Chapter 1: Objectives of Northwest Forest Plan Synthesis

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Origins of the Northwest Forest Plan

In the early 1990s, public controversy over timber harvest in old-growth forests of the Pacific Northwest, the decline of the threatened northern spotted owl, and habitat protection for Pacific salmon populations brought the forest management community to a crossroads. Would management of both public and private forests continue to emphasize production of timber and other commodities, or would public land managers focus more strongly on environmental priorities? This dilemma would not be the first to confront management direction for public lands in the western United States. Nor would it be the first time change was controversial.

By the fall of 1992 injunctions by federal courts (for example Judge Dwyer's decision in Spring 1991)[i] on harvest of federal timber within the range of the northern spotted owl and marbled murrelets had thrown the region into turmoil. Those who argued for the ecological health of the forests were in direct opposition to those who argued for the economic and social benefits of a thriving timber industry. The result was a polarized impasse, and without a basis for a legislative solution, the issue rose to the level of presidential politics. Shortly after taking office, President Clinton fulfilled a campaign promise to the people of the Pacific Northwest and called a forest summit in Portland, Oregon in 1993. The summit ended with President Clinton issuing a mandate for federal land management and regulatory agencies to work together to develop a plan for resolving the conflict between timber and other resource values. This would eventually lead to the creation of the Northwest Forest Plan (the Plan), a massive and unprecedented effort to find a legally binding, socially acceptable, and scientifically-based solution for forest management. It represented a tremendous commitment of resources, and it necessitated redirecting the regional impasse toward a systematic compromise.

To guide the process, President Clinton listed the following five principles, which reflected an evolving set of core values and attitudes about how to manage the Nation's public lands to provide a balance of ecological and economic goods and services (FEMAT 1993):

> First, we must never forget the human and the economic dimensions of these problems. Where sound management policies can preserve the health of forest lands, (timber) sales should go forward. Where this requirement cannot be met, we need to do our best to offer new economic opportunities for year-round, high-wage, high-skill jobs.
>
> Second, as we craft a plan, we need to protect the long-term health of our forests, our wildlife, and our waterways. They are a…gift from God; and we hold them in trust for future generations.
>
> Third, our efforts must be, insofar as we are wise enough to know it, scientifically sound, ecologically credible, and legally responsible.

> Fourth, the plan should produce a predictable and sustainable level of timber sales and nontimber resources that will not degrade or destroy the environment.
>
> Fifth, to achieve these goals, we will do our best, as I said, to make the federal government work together and work for you. We may make mistakes but we will try to end the gridlock within the federal government and we will insist on collaboration not confrontation.

What Exactly is the Plan?

The Plan is a complex set of policies, decisions, standards, and guidelines. Since no single source contains it entirely, what constitutes the Plan is a source of confusion.

Following the forest summit, the White House assembled a team to begin working on the plan envisioned by President Clinton. The resulting Forest Ecosystem Management Assessment Team (FEMAT) developed ten management options that were translated by managers into a supplemental environmental impact statement. In July 1993, Clinton announced the selected option (Option 9), and used it as the basis for a report titled “Forest Plan for a Sustainable Economy and a Sustainable Environment.” The forest management and implementation portion of this strategy was released as a record of decision in 1994, which amended the planning documents of 19 National Forests and 7 Bureau of Land Management Districts ([ROD] USDA and USDI 1994b). We define this record of decision, with its published standards and guides, as the Plan. It caused sweeping changes in the management of federal forests in northern California, western Oregon, and western Washington. It encompasses 24 million acres of federally managed lands within the more than 50 million acre range of the northern spotted owl. It is based on some basic principles of conservation biology (see chapter 7), while also recognizing that in dynamic landscapes some active management might be necessary to achieve goals (see chapter 6). Another important aspect of the Plan to keep in mind is that it is not strictly a scientific plan. It also represents a political and social compromise, and as such it contains facets that do not adhere to any scientific theory. Needless to say, the scale of the Plan presents unique challenges in ecosystem management, adaptive management, and monitoring. What happened as the Plan was implemented did not necessarily reflect its directives. Thus, in the chapters that follow, we refer to what actually happened during the implementation of the Plan.

As stipulated by the Plan, the federal land base was allocated among a network of connected reserves with both terrestrial and aquatic components embedded in a matrix of "working" forests (see fig. 1-1). Management objectives vary by land-use designation, as explained below.

Connected Reserves

With the intention of maintaining connected late-successional and old-growth ecosystems across federal lands, a system of late-successional reserves (LSRs) and riparian reserves was delineated. Late-successional reserves were designed to maintain well-distributed habitat on federal lands for the threatened marbled murrelets and northern spotted owls. The riparian reserve network was intended to reverse habitat degradation for at-risk fish species or stocks, and to serve a terrestrial function by providing a system of old forest structural elements to connect the LSRs.[ii] By creating sufficient habitat for plant and animal species thought to be closely associated with late-sucessional forests, the FEMAT scientists and the managers who wrote the ROD hoped that the Plan could avoid the need to establish new ESA mandated single species management plans for additional late-succession associated species. The design of the connected reserve system was constrained by at least three factors: (1) the location of the remaining pockets of old-growth forests, (2) the locations of "key watersheds" identified by the FEMAT aquatics team, and (3) the portion of the landscape controlled by the federal government.

Matrix

The implementation of the Plan attempted to balance the economic, environmental, and social challenges facing a broad region. Socioeconomic effects were estimated for different land management strategies and were the basis for extensive public debates (FEMAT 1993). Matrix (all federal lands outside of reserves and withdrawn areas) was a key feature in addressing the economic hardship faced by those workers, businesses, tribes, and communities affected by reductions in federal timber harvests. Land designated as matrix was envisioned as the source of commodities, particularly timber, promised under the Plan. At the time the Plan was instituted the timber industry provided the only year-round employment in many rural communities. A substantial number of the mills in those communities depended on timber from federal lands and most rural counties within the Plan area relied on payments in lieu of taxes from the federal government that were based on timber receipts. Ecologically, matrix would provide early and mid-seral habitats that would become scarce within the reserves. Matrix was also intended to provide forested cover between the late-successional and riparian reserve networks.

Adaptive Management Areas

Because the Plan was designed as a dynamic plan that would change as new knowledge came to light, adaptive management areas (AMAs) were created as places where new ideas and concepts for management could be tested. The Plan's emphasis on managing ecosystems, linking scales, monitoring, and adaptive management make it unique. At the time it was established, it was probably the only large scale plan that included all of these concepts. Inclusion of learning opportunities as an integral part of the Plan recognizes the limits of scientific understanding and management experience in manipulating forest ecosystems. In theory it provides a way to confront uncertainty and risk—ultimately improving the quality of natural resource decisions by combining trials of new ideas with monitoring, then allowing for change where necessary.

One of the innovative aspects of the adaptive management system was that it encouraged a localized, individualistic approach—as opposed to uniform, "top-down" guidance. Intended to allow managers flexibility and opportunity to adapt practices to local circumstances, this approach may have led instead to some of the implementation difficulties that would plague the AMAs in the coming decade. Rather than embracing this "freedom," some managers may have interpreted the approach as a lack of organizational support (Stankey and Shindler 1997). Without clear expectations as guidance, some AMA programs suffered from neglect.

The Inner Workings of the Plan: Monitoring

This report focuses primarily on monitoring. Monitoring is required by the ROD (USDA and USDI 1994b); and adaptive management is absolutely dependent on it. It is also mandated under applicable laws and regulations (for example National Forest Management Act of 1976 [NFMA]; Federal Land Policy and Management Act of 1976 [FLPMA]; and the Endangered Species Act of 1973 [ESA]). Furthermore, Judge William L. Dwyer (see footnote 1) stated, "Monitoring is central to the plan's [Northwest Forest Plan] validity. If it is not funded, or done for any reason, the plan will have to be reconsidered."

The strategy and design of the effectiveness monitoring[iii] program for the Forest Plan was initially approved by the Regional Interagency Executive Committee (RIEC) in 1995. Because the Forest Plan did not describe how monitoring should be done, it took several years and many participants to finally publish a monitoring framework (Mulder and others 1999), which was approved by the RIEC in 2001. The objectives of this monitoring framework are to:

> "Evaluate the success of the Northwest Forest Plan in achieving the objectives on federal lands of:
>
> a. Conserving late-successional habitat and related species.

b. Improving watershed condition.

c. Providing resource production and assistance to rural economies and communities."

Federal agencies assigned specific resources to be monitored, to gauge whether these objectives were being met (Mulder and others 1999). Implementation monitoring by Provincial Advisory Committees (PACs) began in 1996. Northern spotted owl population monitoring, which began well before the Plan, was adopted as a component of the overall monitoring module (Lint and others 1999). Monitoring protocols for marbled murrelets (Madsen and others 1999), late-successional old-growth (Hemstrom and others 1998), watershed condition (chapter 9), and tribal consultation (Crespin 2004) have been approved and implemented. Methodology for socio-economic monitoring, possibly the most challenging of all the monitoring activities, continues to be tested and evaluated (Charnley and others, in press b; Sommers 2001; Sommers and others 2002). Methods for monitoring biological diversity and methods for validation monitoring have not been established.

Deleted: yet

Objectives of the Ten-Year Synthesis

The purpose of this document is to review the first ten years of the Plan and reflect on what has been learned—from monitoring and research—to inform future management directions for federal forest lands in the Pacific Northwest and northern California.[iv] This report takes the notable step of initializing the closing of the adaptive management loop—completing a cycle of planning, acting, monitoring, evaluating as a basis for subsequent planning, and modifying implementation as appropriate. Such a closure has rarely been accomplished before, at least on a regional scale. Authors of the various chapters will point out what worked and what did not, identify what has changed over the Plan's first decade, and discuss how new information or unexpected events might influence the future functioning of the Plan.

In focusing on how well expectations of the Plan were met, we recognize that expectations are based on values, and that societal perspectives shift and flow. Natural resources are human conceptions; and complex shifting values surrounding these constructs (often oversimplified into polarities like "owls versus jobs" or "economy versus ecology") are eventually reflected in natural resource policy (Clark and others 1993). As we review the Plan, we attempt to remain as objective as possible by highlighting the perspectives and world views that framed its creation and implementation.

Although President Clinton outlined an array of societal, ecological, and organizational principles to direct FEMAT, researchers were instructed to consider ecological values first, before other societal values (FEMAT 1993). This ecological-values-first approach was a policy decision, not a science one, and reflects the fact that forest management is inherently a political undertaking (Clark and others 1993). Meanwhile, perspectives have continued to evolve. For example, international agreements on sustainable development now focus on balancing ecological and social values. Other regional assessments have also adopted a co-dominant, multiple-use perspective (Quigley and others 1996). In general, we interpret Plan performance by using the ecological values-first perspective; we leave open policy considerations when we develop ideas about future management.

We begin convinced that 10 years is not enough time to answer many of the relevant ecological questions. The ecological processes the Plan was intended to influence or protect play out over centuries and millennia. Even so, after 10 years we can discern whether some of these processes appear to be on the right track or are spinning off on unanticipated trajectories, though any conclusions are only provisional. Such inferences can only be made by using a combination of empirical data—where available—and the collective knowledge and experience of scientists and resource managers familiar with ecosystems covered by the Plan. For non-ecological issues, sufficient time has passed to determine whether some of the principles President Clinton spoke of at the Portland Forest Summit in 1993 of have been followed. For example, we can evaluate how the Forest Plan has influenced social systems, and assess whether this influence matters to economic conditions in the region. We can speak to the success of establishing monitoring programs. We can also determine if federal agencies really work more closely together then they did in the 1980s. Finally, we can discuss the success of the adaptive management process.

Uncertainty and Complexity

Two themes have evolved that will reappear throughout this report, one involving the complexities of scale, and one involving uncertainty. The concept of scale comes into play in both a spatial and a temporal context. Spatially, we think of scaling as the way vegetative structures and patterns are arrayed across the landscape from very small patches (less than an acre) to large blocks that could conceivably cover whole watersheds. Temporally, processes like fire could occur over a few hours or days, while development of old-growth structures could take a century or more. Dealing with scale becomes quite difficult when contemplating multiple ecological and social values that occur over different spatial elements and temporal frames. Integration of planning and implementation of management across federal agencies (each with a history of acting independently on site-specific activities) further complicates the issue.

We also highlight uncertainties that influence how we interpret what is and what is not known. We discuss the variability, adaptability, and interdependency of natural and social systems as the basis for uncertainty, and contemplate what managers might consider in response. Specifically, our experience has emphasized the importance of recognizing there is a continuum of forest conditions and stages. For example, during the past decade we have seen rapid evolution among different stakeholder groups of definitions for old-growth to the point that contemporary definitions (stands of natural origin greater than 100 or 120 years) have little scientific basis. We have seen similar ambiguity in the definitions and specifications of the term “reserve.” The Plan calls for a system of connected reserves; however, in developing this approach, insufficient attention was given to both the implications of a highly dynamic landscape and what flexibility could be considered after broad-scale disturbances. For example, the framers of the Plan anticipated that fires would occur, especially in the drier provinces. They did not, however, anticipate the size, number, or placement of the fires that did occur. Some events, like the range expansion of barred owls, were completely unanticipated.

Both management and science experience suggest that the complexities of ecosystem management and uncertainties of both internal and external processes and events can confound the best-laid plans. Contributing to these complexities and uncertainties are the role of private lands in meeting Plan intentions, the influence of lands and systems like headwater streams that had not been considered as part of the habitat for selected species, the implementation of a multiscale plan where little attention was focused on mid-scale planning, the role of disturbances, and differences in how federal agencies approached Plan implementation. Given these limitations and inevitable information gaps, asking whether expected responses were reasonable and whether solid conclusions can be expected in just ten years are fair questions.

Looking Ahead

We acknowledge that some emerging issues are likely to challenge both scientists and managers in the coming decade in areas where we can only offer scant information. These issues include such questions as: How does climate change impact the effectiveness of the Plan as a risk management strategy? To what extent can hazardous-fuel reduction treatments (undertaken in the context of the Healthy Forest Restoration Act [HFRA] of 2003) be conducted in matrix stands or in LSRs in the Plan's drier areas? What are the unintended social and economic consequences of implementing the Plan and where will they manifest themselves? What are the ongoing changes in societal values that will shape the next rounds of plans for Forest Service and BLM management? To what extent are the Plan's ecosystem management approaches consistent with approaches to sustainability being enhanced by land managers in North America? How sustainable is the Plan, given the increases in demands for ecosystem goods and services as human population increases? How can strategies for managing invasive species be applied in the Plan area?

Our Goal: To Inform the Debate

On the world stage, the Plan is recognized as a unique undertaking in the world forest management community. The Plan's emphasis on partnerships among scientists and resource managers, ecosystem approaches, linkages among scales, monitoring, and institutions for coordinating and using adaptive management practices are all distinctive. The Plan combined a variety of tactics, such as an economic adjustment initiative to provide temporary support to people whose jobs were affected by changes in land management strategies. Looking back over the past ten years offers an unusual opportunity for a broad-scale examination of the effectiveness of such programs intended to mitigate social and economic impacts of the Plan.

To a large degree the chapters that follow are written by scientists who participated in FEMAT (1993), which provided the scientific foundations for the Plan. They have also provided guidance on the Plan's monitoring modules. Consequently, they bring a unique point of view to this document. Some might argue that they have been too close to the process and therefore cannot possibly provide an unbiased evaluation. Others would say that because they have been so close to the process, only they can offer the kinds of insights provided here. One thing is certain: this document probably represents the last time this group will assemble as a unit to write in such detail about the Plan, because while ten years is not a long time in the life of an old-growth forest, it is in the life of a scientist. The controversial issues that necessitated President Clinton's forest summit in 1993 are part of the same debate that has been with us for over a century and is still with us today. In presenting the information, ideas, and perspectives in this report our goal is simply to better inform that debate.

The report is organized as follows:

Part I

Chapter 1: Objectives of the Northwest Forest Plan Synthesis. Provides an overview of the Plan's origins, describes its principles and land-use allocations, discusses its monitoring module, and outlines the objectives of this synthesis report.

Chapter 2: Context for the Northwest Forest Plan. Reviews the context leading to the Plan, including the philosophical and legal basis, background information on the environmental movement and the timber industry, and the differences in agency culture. The chapter concludes by reflecting on the continually shifting nature of the context for managing federal forests.

Chapter 3: Synthesis: Interpreting the Northwest Forest Plan as More than the Sum of Its Parts. Considers the Plan as more than the sum of its parts: by examining all findings together, by looking at changes in the last 50 years to gain the perspective of time, by examining some general management principles, and by looking forward through opportunities to address three major management issues, contingent on the desired balance of ecological and commodity values.

Chapter 4: Summary. Discusses measurable progress, validity of assumptions, and advances in learning as a basis for looking to the future are discussed. We explore appropriate scales, tradeoffs through time, and links between processes and resulting patterns, and end with a discussion of future flexibility.

Part II

Chapter 5: The Socioeconomic Implications of the Northwest Forest Plan. Summarizes how well the Plan met the socioeconomic needs outlined in the President's principles, and discusses several unexpected changes in community stability, timber markets, and the role of nonfederal lands. Also takes on issues of sustainability and multi-agency decisionmaking.

Chapter 6: Maintaining Old-Growth Forests. Reviews what was expected for, and what happened to, older forests, and details understandings that have developed since the Plan was written. This chapter explores the effects of disturbances on the reserve system, uncertainties such as climate change, and the controversies with post-fire salvage in reserves. Much of the discussion is based on the idea that biodiversity can be managed by managing for ecosystem characteristics. The chapter ends with a range of reserve strategies contingent on the desired balance of ecological and commodity values.

Chapter 7: Conservation of Listed Species: The Northern Spotted Owl and Marbled Murrelet. Reviews changes in owl and murrelet populations and habitat, sources of uncertainty, validity of assumptions, and new research findings.

Chapter 8: Conservation of Other Species Associated with Older Forest Conditions. Explores viability analysis, lessons from the Survey and Manage Program, and the effectiveness of the reserve system.

Chapter 9: The Aquatic Conservation Strategy of the Northwest Forest Plan: an Assessment after Ten Years. Reviews the aquatic conservation strategy central to the Plan and the available findings from aquatic-system monitoring, and examines new research findings, checking for consistency with the conservation strategy. It also discusses new ideas about ecosystem dynamics, the role of fire in riparian reserves, and problems with managing at both small and large scales.

Chapter 10: Adaptive Management and Regional Monitoring. Examines the processes of adaptive management and regional monitoring used to achieve Plan goals and to direct change over the long term. Also discusses uncertainties related to the precautionary principle, learning strategies, and issues surrounding linking what was learned to changes in practice. Finally, the authors suggest ways to improve adaptive management and monitoring.

Figure List

Red areas are national parks or are FS or BLM land designated as wilderness or late-successional reserves, where various wilderness, wildlife, recreation, and other uses are emphasized. Black areas are matrix allocations where some logging is permitted in support of local communities. Blue areas are adaptive management areas with a focus on learning. White areas are private and state lands.

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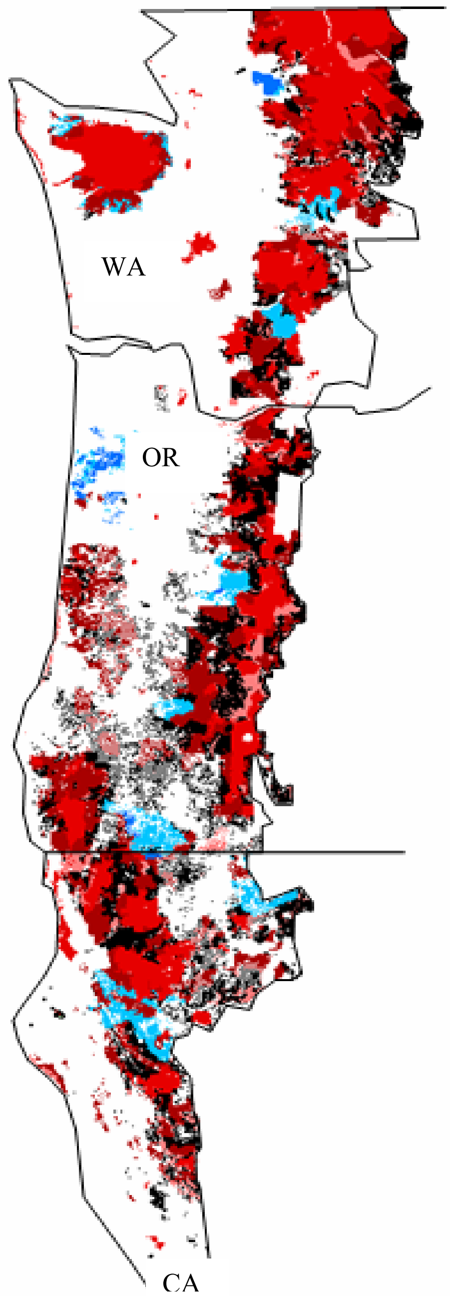

CHAPTER 2: Context for the Northwest Forest Plan

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INTRODUCTION

Although set in the Northwest, the issues at stake in the Northwest Forest Plan (the Plan) are much broader—and much debated. The balance President Clinton described between utility and protection when charging federal agencies to develop the Plan (see chapter 1) has been sought after for more than a century. In 1890, with the closing of the American frontier, came the realization that the Nation's resources were finite; and from that point on debate has circled around virtually every management decision relating to land in the public domain. This debate has often centered on should this land be viewed primarily as a source of economic opportunity, or as a national treasure to be preserved untouched? During the past century, legislation associated with this debate has created the Forest Service, the Bureau of Land Management, the National Park Service, the Fish and Wildlife Service, and several smaller federal land management agencies to administer public lands in the western United States.

Our task in this chapter is to briefly review the historical, philosophical, and political contexts leading up to the Plan, and to address the continually shifting nature of social movements and land management debates. Two commentaries on the establishment and objectives of the Plan that are particularly useful in this respect are those by Tuchmann and others (1996) and Pipkin (1998). These commentaries are especially insightful since their authors were key players in implementing the Plan. Pipkin's report discusses the genesis of the Plan, its achievements, some of the lessons learned, and organizational changes resulting from it. The Tuchmann report provides a brief overview of the political and management histories of federal lands that set the stage on which the creation of the Plan was eventually played out. It also discusses the evolution of social awareness and expectations for land in the public domain, which has been reflected in corresponding federal legislation, and has continued to inspire debate as to the appropriate role of government in managing public lands. We dig a little deeper into the laws associated with different phases of public perception to provide context for the discussions in subsequent chapters about the different types of monitoring that have been performed under the Plan, and whether it is meeting society's expectations. Note that although the Plan is based in science, it was and still is a political not a scientific document (FEMAT 1993). Thus its power comes from the legislative and legal system, not the scientific literature. As Judge Dwyer said when he issued his final ruling on the Plan, "It does not matter whether this is the best plan, it only matters that it fulfills all of the legal requirements."

PUBLIC PERCEPTION AND THE ROLE OF GOVERNMENT IN LAND MANAGEMENT

Up to and through the last half of the 19th century, disposal of public lands was a primary objective of federal land law and policy. In fact, public lands presented a managerial burden to the federal government, which saw them as redeemable only through settlement, cultivation, and profit. Providing land as an incentive for settlement (such as homesteading) or development (such as railroads) was seen as a way to "conquer" the wilderness and claim dominion over the West. To best encourage this empire-building "redemption" of the land, the most desirable public land was disposed of first. In the mountainous West, this meant the lower elevation areas and flatter valleys that contained the most productive timber stands or rangeland and were most suitable for agriculture. The fact that these areas largely ended up in private hands would one day dictate the management options available to public agencies as the Plan was designed.

As civilization made increasing inroads into the Nation's wild areas, the end of the 19th century also saw the rise of the conservation and preservation movements (Hays 1959). George Perkins Marsh (1864) description of the transformation of the environment as a feature of human history and the role that clearing of forests played in human development influenced the evolution of these movements. Conservationists, such as Gifford Pinchot and Theodore Roosevelt, believed that natural resources should be managed to provide a sustainable source of wealth and national prosperity. On the other hand, John Muir, representing preservationists, believed that wild places should be set aside to be entirely protected from human hands. In the formulation of the differing viewpoints held by those like Muir and Pinchot, the separation between conservation and preservation was born. And as these movements gained momentum, federal legislators began to recognize the merit in retaining management control over more and more federally administered land. This realization came in fits and starts, however, and was applied differently to different parts of the federal land portfolio. What follows is a brief look at how the creation of various land management agencies dealt in different ways with defining the role of the government in administering public lands.

THE CREATION OF THE FOREST SERVICE

In 1897 the Organic Act created new forest reserves, totaling more than 21 million acres, to protect the sources of the West's water, manage grazing, and regulate timber harvest. The forest reserves were transferred to the Forest Service in 1907 and became the backbone of the national forest system.[v] These events were intended to regulate the use of federally administered lands, with the twin goals of protecting natural resources and providing economically valuable commodities. As Gifford Pinchot envisioned it in his autobiography, the creation of national forests should provide the greatest good for the greatest number of people (Pinchot 1947). Pinchot's vision of how to manage these forests came through strongly in his autobiography, especially when berating preservationists who wanted to save every tree: "Their eyes were closed to the economic motive behind true forestry. They hated to see a tree cut down. So do I, and chances are that you do too. But you cannot practice forestry without it." (Pinchot 1947). (In contrast, Muir had little faith in human intrusions on forests and wilderness: "Unless reserved or protected, the whole region will soon or late be devastated by lumbermen and sheepmen, and so of course made unfit for use as a pleasure ground." [Muir 1912]) In keeping with the ethic of the conservation movement, the creation of national forests resulted in greater federal control, though national forest managers generally followed an extensive, low-level management model. Forest managers have maintained an enduring belief that society values its national forests more for their wildlife, water, and recreational opportunities than for commercial values such as timber or grazing (Kennedy and others 2005).

THE CREATION OF THE BUREAU OF LAND MANAGEMENT

Although the Bureau of Land Management's mandate is now primarily one of management, its roots are very different from the Forest Service's mandate. The BLM can trace its origins to the General Land Office (GLO) which was created in 1812 to administer federal lands, and was eventually given the responsibility of disposing of them to encourage settlement and development. The BLM, the second largest land management agency associated with the Plan, was created through the merger of the Grazing Service and the GLO in 1946; but another 30 years passed before its mandate was clearly stated through that agency's own "organic" act, the Federal Land Policy and Management Act (FLPMA) of 1976. Through a combination of controversy, happenstance, and design, the BLM gradually increased its management role and decreased its disposal role. This new focus was reflected in changes in BLM's approach to forestry, which emerged in the 1970s as a multidisciplinary management program including recreation, wildlife, grazing, watershed, and cultural resource programs.

Explaining the evolution of BLM's forestry program involves going back to one of BLM's predecessors, the GLO. In 1937, the Oregon and California Revested Lands Sustained Yield Act (O and C Act) had restored federal ownership of about 2.7 million acres of forest land in western Oregon by giving it to the GLO. A key feature of the O and C Act was its stipulation that management of the O and C lands, some of the best timber stands in the United States, would help support the economic well-being of communities in the O and C area and provide a substantial portion of timber revenues to the counties within these lands (Muhn and Stuart 1988). The BLM inherited the O and C lands, and their mandate, when it was created in 1946. Timber production became politically important to the BLM as it recognized the importance of these lands (which make up most of the timberlands currently managed by the agency) to the economic well-being of many local communities (Muhn and Stuart 1988). Decades after the O and C Act, its consequences would play a large role in both providing land for the Plan, and creating controversy about the Plan's design and implementation because of the expectation of sustained timber yields and revenues to counties.

THE CREATION OF THE NATIONAL PARK SERVICE AND FISH AND WILDLIFE SERVICE

The National Park Service (NPS) and Fish and Wildlife Service (FWS) are the other two federal agencies that manage substantial acreages within the Plan area. Their histories and mandates are quite different than those of the Forest Service and BLM. Both NPS and FWS have their roots in the preservation movement of the late 19th and early 20th centuries. The National Park Service's beginnings stem from the preservation of the two million acres of beautiful and geothermically unique land of Yellowstone National Park in 1872. By 1916, when 19 national parks and 21 national monuments had been created, the preservationist role of the agency had been fairly well defined (Clarke and McCool 1985). Although it is possible to trace the lineage of the Fish and Wildlife Service back to 1871 it has only existed in its current form since 1970 and does not have an organic act describing its role (Clarke and McCool 1985). The FWS has a duel mandate of management (for National Wildlife Refuges), and regulation through its consultative role under the National Environmental Policy Act of 1969 (NEPA). Together with other regulatory agencies like NOAA Fisheries and the Environmental Protection Agency it provides oversight of ESA reserves in environmental assessments (EAs) and environmental impact statements (EISs) prepared by management agencies as part of their planning. The management roles of NPS and FWS (at least for refuges) have not changed materially since their inception.

AGENCY CULTURE AND THE PLAN

An important concept for contextualizing the formation of the Plan is that the mandates of the various federal agencies responsible for managing and regulating federal lands within the Plan area have evolved at different rates and in different directions over the past two centuries. This disjunction has created distinct cultures within these agencies, causing friction during the establishment of the Plan, and presenting difficulties in fulfilling President Clinton's stipulation that the Plan help federal agencies work together.

We think some notion of how these cultural differences arose is important to understanding the way the Plan has functioned over the past 10 years. At the same time we recognize that our interpretations will not be viewed as universally correct or even important by everyone who wants to evaluate the Plan.

The century-old debate over natural resource management has manifested itself in various ways in the formation of federal land agencies. The preservationist model, which values “nature untrammeled” and encourages management that sets aside land to allow natural processes to predominate, largely guides the management practices of the Fish and Wildlife Service and the National Park Service. In contrast, the conservationist model calls for management activities that manipulate forest structure to achieve outcomes desired by humans, whether the objectives are commodities or other environmental goods and services. Today, these management activities frequently are designed to mimic ecological processes. This conservationist line of thought has driven much of the management activity on Forest Service and BLM-administered land.

This is an important distinction which has probably attracted different sorts of people to the various agencies over the years. These differences in corporate philosophy were certainly a factor in development of the Plan and they have influenced its implementation as well. Because of the dissimilar ways in which the agencies were established and structured, achieving interagency cooperation proved elusive–especially in the beginning of the forest planning process. For one thing, pre-existing conflicts had to be dealt with before true coordination could happen. As one example, before the northern spotted owl was listed as a threatened species in 1990, the Forest Service and BLM were not required to consult with the FWS about management implications to owl habitat. Once the owl was listed however, the agencies had to consult and address some highly complex issues–a process that greatly slowed their ability to reach decisions on things like timber sales (Tuchman and others 1996). This lack of smooth coordination followed the agencies into the forest planning process. Along these lines, Jack Ward Thomas, who headed the Forest Ecosystem Management Assessment Team (FEMAT), related his frustration at the clash of agency objectives during negotiations over the Plan. He felt that the FWS was too single-minded in its emphasis on the northern spotted owl, and that this caused a stagnation of agency collaboration. “The situation with the Fish and Wildlife Service has been dragging on for nearly five years,” he wrote. “They keep the Forest Service and Bureau of Land Management from any type of methodical approach to management of the forests of the Pacific Northwest” (Thomas 2004).

THE ENVIRONMENTAL MOVEMENT AND THE PLAN

While the federal land management agencies were forming and gaining substance, the nation continued to undergo transformations that shaped American society’s thinking about the role of federal lands. After an initial wave of conservation successes that created 230 million acres of protected land (as 18 national monuments, 5 national parks, 51 national wildlife refuges, and 150 national forests), the Great Depression and then World War II sent conservation issues into the shadows as the nation dealt with other urgencies and deprivations. When the war ended, a dramatic postwar boom propelled the nation toward economic and social expansion. In order to fuel this expansion, demand for wood increased significantly, resulting in a change in management policy that shifted federal land management practices toward a timber production model resembling that used on industrial timber lands. This was particularly true in coastal Washington and Oregon.

After World War II, even as a more intensive industrial forest management model was being created, the American public began to recognize that timber harvest on public lands potentially threatened other resource values. Quality of life was improving, with industry pushing forth a stream of new consumer goods, and Americans enjoying new amounts of leisure time and money. Along with this came a new appreciation for the natural world as a source of recreation and also as a source of fresh air and clean water—especially as rapid industrial growth began creating more and more pollution. The conservation movement reacted to these changes, evolving from the turn-of-the-century emphasis on utilitarian resource-use policies into an emerging ecological awareness that perceived humans as part of the larger natural world. This perception recognized that human activities were putting heavy burdens on the fragile systems that support life. As it became a coherent new concept, "environmentalism" also became a potent force for change (Scheuering 2004).

Through the 1960s, 1970s, and 1980s a steady progression of environmental legislation and regulations reflected the nation's increasing environmental awareness. In 1964, the Wilderness Act gave impetus for preserving selective areas of high recreation or wildlife values. Many of the first congressionally designated wilderness areas were centered on primitive areas that had previously been set aside by the Forest Service or BLM, but what was revolutionary about the Wilderness Act was it set aside land for no other purpose but its own preservation–showing recognition by the federal government that land had value even when left undisturbed. The Federal Water Quality Act (the Clean Water Act) was passed in 1965, the Clean Air Act in 1967, and the Wild and Scenic Rivers Act in 1968. When the groundbreaking National Environmental Policy Act (NEPA) was signed in 1969, it showed that even the Republican Nixon administration felt compelled to respond to the growing public demand for environmental regulations. By April 22, 1970—the first Earth Day—the environmental movement had truly arrived. Rachel Carson's Silent

Spring (1962) and Paul Ehrlich's The Population Bomb (1968) were speaking to an increasingly informed and concerned public—and the Sierra Club had grown into a potent political lobby representing 78,000 members.

As society became better versed in ecological principles, its demands on federal land management agencies became more nuanced. The environmental agenda came to include an increasing interest in complex issues such as the restoration and conservation of biological diversity. During the early 1970s, the Endangered Species Act of 1973 (ESA), the National Forest Management Act of 1976 (NFMA), the Federal Land Policy and Management Act of 1976 (FLPMA), and a variety of other laws and regulations documented these concerns for biological diversity on federal lands. Inevitably these changes in law and policy resulted in conflict between those interested in maintaining commodity production as a major, if not primary, objective for federally administered lands and those favoring non-commodity values. In fact, as the environmental movement gained power, it also mobilized its detractors.

The NFMA (1976) and FLPMA (1976) were born of the ideological concerns for the environment and increased interest in public involvement in government decision-making that characterized the 1960s and 1970s. They remain the principal statutes driving national forest and BLM planning today.[vi] Although they did not change the multiple use and sustained yield focus of federal forest management, NMFA and FLPMA called for extensive planning and public involvement. The intent was to reconcile competing public demands at the scale of the individual national forest or BLM district. Congress recognized that conflicts among resource extraction, amenity values, and ecological issues such as biodiversity were an integral part of public land management. Rather than resolve such conflicts legislatively, Congress enacted a procedural planning process wherein it was hoped that a thorough and open analysis involving "integrated consideration of physical, biological, economic, or other sciences" would make possible local resolution of conflicts and wider acceptability of decisions. Each national forest, grassland, and BLM district was required to develop a land and resource management plan with the purpose of guiding all resource management activities for a 10-15 year period.

A key feature of the Forest Service's interpretation of NFMA (1976) was the inclusion of the "viability clause" in the 1982 forest planning regulations. This clause brought increased visibility and importance to species viability within forest planning. Section 219.19, Fish and Wildlife Resources, of the 1982 rule stipulates:

> Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area. For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area. In order to insure that viable populations will be maintained, habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area.

The viability clause would become a central factor in the legal battles that arose over the northern spotted owl and ultimately the design of the Plan. At about the same time, ESA mandated that species whose continued existence was threatened or endangered, and the ecosystems they depend on, would be given special management consideration. NEPA required consideration of the cumulative effects of management activities at the project planning stage. The combination of NFMA, ESA, and NEPA and the regulations developed to enact them were effective tools for promoting conservation of biological diversity.

These regulations and guiding principles, which arose in response to social concerns and the increasing political influence of the environmental movement, set the stage on which the Plan took shape. Controversy arose when views over the appropriate role of the government in natural resource management clashed. The managers and scientists who developed the Plan attempted to deal with this public debate. They quickly realized that even the forest plans required under NFMA covered too small an area to effectively address regional issues; a larger landscape plan was needed to attack the viability question for northern spotted owls and marbled murrelets as well as the habitat needs of anadramous fish. They also realized that there was much that they did not know, and that the Plan would need to be versatile and open to change, especially considering the inevitable shifts and changes aligned with societal expectations.

TIMBER IN THE PACIFIC NORTHWEST

It is not possible to consider the Plan in isolation from the timber issue: if not for this issue it is unlikely that any other human activity would have impacted forest structure enough to raise concerns about the viability of old growth associated species. The forest products industry in California, Oregon and Washington has played a major role in the region—impacting both the region's economy and ecosystems in ways that are not usually apparent in other U.S. timber-producing regions.[vii] Recognizing this, the Plan contained specific provisions that promised timber would continue to flow from federal lands. This guarantee of continued timber production was a key factor in making the Plan politically viable (Pipkin 1998).

The region's forest products industry developed as the demand for wood reached new heights during the post-World War II baby boom. From the late 1940s until the late 1980s, timber harvest in the Douglas-fir region increased roughly 25 percent, fueled mostly by increased harvest on public lands (see figs. 2-1a, 2-1b, data from Warren 2004). In fact, between 1945 and 1965, timber harvest on Forest Service land in the western forests of Oregon and Washington rose from about 149 million cubic feet (745 million board feet) to 807 million cubic feet (4,035 million board feet) (Tuchmann and others 1996). Note that this was the same period that saw the rise of the environmental movement, which meant federal land agencies had to address the growing ecological concerns of the public at the same time that they were changing forest structural conditions to an extent that the West had not seen before. One way this happened was with the passage of the Multiple Use-Sustained Yield Act (MUSYA) in 1960 and the Classification and Multiple Use Act in 1964 (CMU), which set the stage for adoption of management models by the Forest Service and BLM respectively that were considerably different from the industrial model. They called for and defined sustained yield (of timber or other commodities) as "the achievement and maintenance in perpetuity of a high level annual or regular periodic output." The ensuing implementation of the MUSYA led to the Forest Service adopting (in 1973) a non-declining even flow policy for harvest levels.

Meanwhile the forest products industry was expanding. The advent of mechanical processing made the use of abundant large diameter timber feasible, and the development of inexpensive transportation systems encouraged delivery of products to the eastern United States and east Asian markets. Rapid economic growth in Pacific Rim countries opened international markets to the coastal areas of the region and the log export trade grew rapidly (see fig. 2-2), buoying stumpage prices. The rise and fall of the log export market would play a particularly important role in the management of the region's private timberlands and for state lands in Washington. Export markets favored larger, older, high-quality[viii] trees. When the export of logs from federal timberlands was banned in the 1970s, it provided an incentive for private landowners to manage on longer rotations. This had the ancillary (and temporary) benefit of increasing the proportion of older forests (greater than 60 years) on some private lands, particularly non-industrial private forest lands. Prior to the establishment of the Plan, however, effectively all of the old-growth forests on industrial private land and most of the old-growth on non-industrial private forest land had already been harvested. In fact, the proportion of the private inventory composed of trees >160 years old dropped from 15 to less than 1 percent during the past 50 years.

A second consequence of the log export ban was that it created a plentiful resource domestically for large log mills that specialized in cutting public timber. But the design of the mills that purchased federal timber made it particularly difficult for them to adapt to major changes that would soon shape the industry. Particularly difficult for them to survive were the injunctions on the sale of federal timber that occurred just prior to the implementation of the Plan, which caused wood supplies to fall below existing processing capacity. For mills that were dependent on federal timber, size also mattered: by and large they simply could not efficiently process smaller logs. For these reasons, through the early 1990s these large log mills closed their doors. When the Asian economic collapse hit in the mid-1990s the region's capacity to process logs larger than about 20 inches was mostly gone. Private landowners who tried to shift sales of export-quality logs into the domestic markets found that rather than the premium they had come to expect over the past quarter century, these logs were now discounted. The result has been an inevitable shift toward forest management regimes that favor shorter rotations (see fig. 2-3). Today the economic incentive for all private landowners is to grow smaller, more uniform trees, which has actually widened the gap between ecological conditions on public and private land. These younger forests will not provide the same type of biological diversity as was traditionally found on non-industrial private forest lands.

Sidebar: Public vs. private land: the challenge of designing LSRs

The bifurcation of conditions between public and private forest land complicated Plan design, because part of the political compromise associated with the Plan was that it would only affect federally administered land. This eliminated much of the land with the best potential for spawning and rearing habitat for coho salmon because these low-lying coastal areas are largely in private hands. In general, the desire to protect the remnants of old forest and key watersheds dictated placement of LSRs within the federally controlled landscape. According to Miles Hemstrom who was then the regional ecologist for the Pacific Northwest Forest Service's Region (R6) and participated in designing the reserves, the process was intended to include the best remaining blocks of old forests, whenever possible in key watersheds, while paying attention to known spotted owl occupation areas. This set of criteria begs the question, strictly from a scientific standpoint, of whether the existing reserve network is the most desirable network even though it was the most pragmatic network given the combination of land ownership and existing vegetation patterns that existed at the time. This suggests that the current reserve network could, in fact, be inefficient and that some other network could provide the things promised by the plan using less space and in less time. But it is important to remember that even though scientists might be able to recommend a more efficient plan there is currently no political push to do so.

ISSUES AT STAKE IN THE PLAN—STILL DEBATED

Tension and debate surrounding society's perspectives on forest management will always be with us. These tensions primarily reflect competing values and worldviews. Each philosophy is based on a set of complex hypotheses, some which the scientific community is only now beginning to imagine how to test. In a sense, the Plan is an elaborate case study that might begin to determine whether these philosophies are truly exclusive, or if they can coexist on the same piece of land at the same time. The Plan attempts to blend these opposing views of natural resource management by using a mix of elements from the scientific fields of conservation biology, silviculture, and ecology.

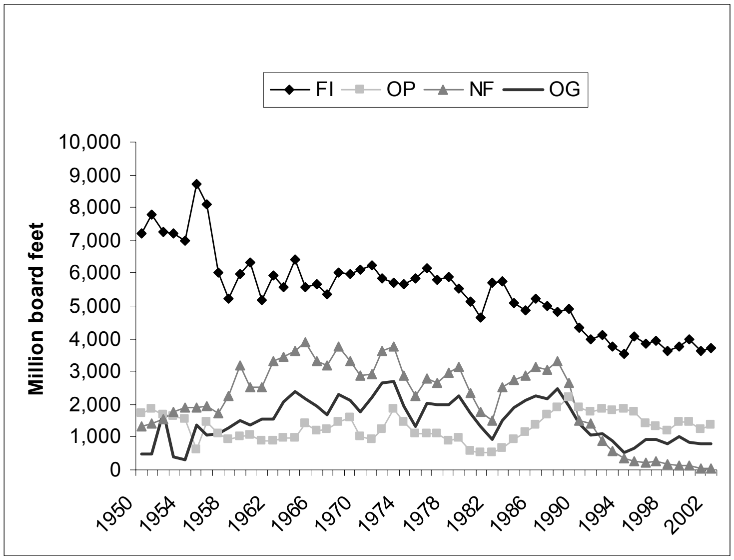
The Plan is not simply a scientific document, it attempts to address the socio-political conditions that made it necessary. It attempts to address questions of economic well being by considering how jobs in timber dependent communities will be affected and recognizing other cultural issues generated by political decisions associated with the Plan. As a result it layers the fundamental questions about maintaining ecological processes and biological diversity onto a social question that asks how we might manage public lands to address the environmental, economic, and social equity concerns that shape Americans' everyday lives.

Furthermore, although tension and debate surrounding the competing values of forestry will always be with us, the intense regional conflict that led to the development of the Plan has receded to a more manageable level. Ten years ago the region faced an injunction on timber harvest on federal forest lands, and was mired in legal battles and emotional debates. Out of this came the tremendous efforts of the administration and federal agencies to redirect the regional standoff toward compromise. As Pipkin describes it: "The Northwest Forest Plan was upheld by the courts, the injunctions were lifted, and the region began to move forward again. This was an important accomplishment—from a situation characterized by stalemate, with no end in sight, to one in which progress could be made on ecological, economic, and social fronts." (Pipkin 1998). Ten years later we recognize that conflicts will continue, and there is still room for improvement. However, the Plan, with its common vision for the management of federal lands, can take credit for defusing a volatile situation and creating a more civic atmosphere.

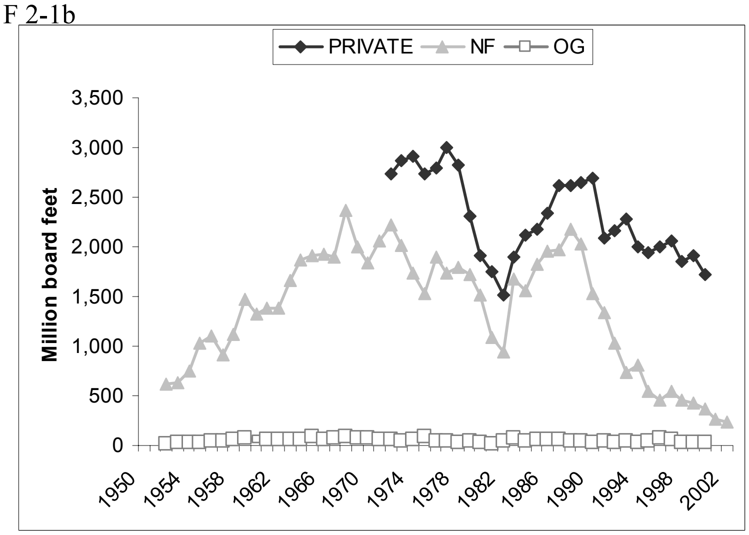
Deleted: of opportunity instead of opposition

Figure List

F 2-1a

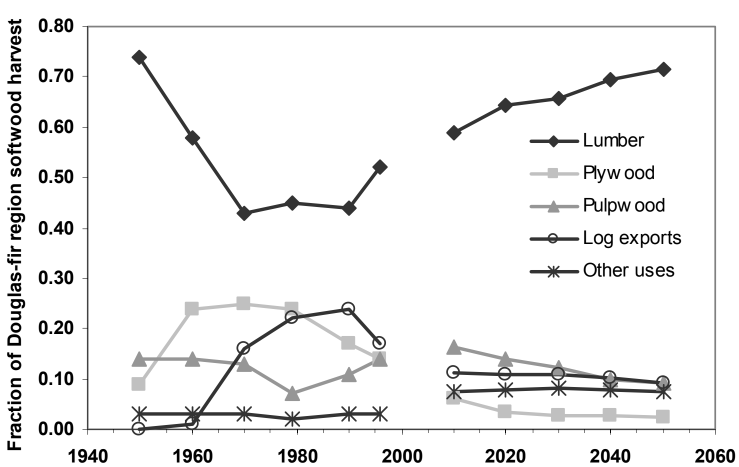


F 2-1b



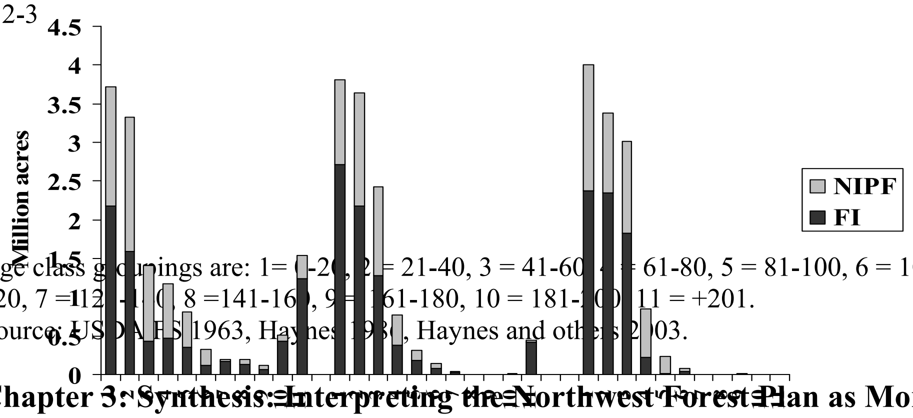
Source: Warren 2004.

F 2-2



Source: Haynes 2003.

F 2-3



Age class groupings are: 1= 0-20, 2 = 21-40, 3 = 41-60, 4 = 61-80, 5 = 81-100, 6 = 101-120, 7 = 121-140, 8 =141-160, 9 = 161-180, 10 = 181-200, 11 = +201.
Source: USDA FS 1963, Haynes 1986, Haynes and others 2003.

Chapter 3: Synthesis: Interpreting the Northwest Forest Plan as More than the Sum of Its Parts

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Introduction

Chapters 5 to 10 interpret the status and trend reports and available science for each of the six major Plan elements (socioeconomic implications; the conservation of: old-growth forests; listed and other species; aquatic systems; and adaptive management and regional monitoring). Each element was individually addressed, partly as a way to help understand and explain them, and partly because science is organized by discipline. Here, we consider the elements collectively. We also take the liberty to examine broader contextual factors and look for patterns in available data extending back as far as 50 years. Then we turn our attention to examining possible directions for federal forest management in the next 50 years. We also explore how these perspectives can be integrated with management and policy. Integration starts by recognizing that federal land managers and researchers have very different roles and perspectives. Managers are responsible for developing and applying coherent management strategies to meet complex societal goals, with legal, funding, and personnel constraints, and through public input. Management strategies also seek to integrate various researchers' disciplinary perspectives and be consistent with management experience and knowledge. We seek here to help with this difficult task by revisiting principles of science-based management and by illustrating the debate needed to integrate science and policy, from our perspective as researchers, through specific examples.

Interpreting the Collective Evidence from the Plan's First Decade

Our condensed tabulation of Plan performance (table 3-1) suggests a collection of met and unmet expectations, depending on individual points of view. People most concerned with ecological conditions may be pleased with many of the changes. People concerned mostly about timber-dependent communities and adaptive management processes will likely be less pleased but may also believe that outcomes could have been much worse. The decline of northern spotted owl populations in the southern part of their range was at the low end (2 percent per yr) of the wide range of expected decline (0.7 to 8.4 percent per year; chapter 7), but at the high end (7.5 percent) in Washington for reasons not well understood—possibly related to

increasing barred owl populations. The decade saw a net increase in older stands that may eventually support more owls. The area of stands that grew into large size-classes was greater than losses of older stands from harvesting and fire, even with the 500,000-acre Biscuit Fire. Marbled murrelets appeared to maintain their population, although monitoring is limited to the last 4 years and results may be confounded with changing ocean conditions and a variety of other factors. Multiple interpretations suggested that older and riparian forests did better than expected, a result of lower than expected harvest in the matrix and changes as forests grew into larger size-classes. At the time the Plan was written, species habitat models were often seen as a way of determining population trends more efficiently and less expensively than by direct measures. We have learned that building habitat models to predict populations is frequently as complex and difficult as estimating actual populations; thus, models may not be good substitutes for population estimates. In general, habitat remains necessary, but not sufficient, to support persistent populations; that is, the Plan can support conservation and restoration of habitat but wildlife populations may respond to a variety of other factors, only some of which are driven by habitat.

Continuing lawsuits and other forms of dissatisfaction suggest that desired consensus and trust in management have yet to be fully achieved. Timber production was far less than expected in the matrix allocation; a small portion of this loss was made up by greater than expected production from thinning in plantations in late-successional reserves. Interviews suggested that timber-

dependent communities were disappointed in the Plan, but census data suggest that a relatively small number of communities were severely affected. Some job losses were offset by unexpected factors such as a generally good regional economy, and new services and development to accommodate inflowing retirees. Pronounced losses of federal jobs were observed, more than 50 percent on some Oregon and Washington national forests (Charnley and others, in press b). Losses in Plan-area national forests in northern California were somewhat less, and BLM District jobs were relatively stable. Average national forest non-fire budgets in the Plan area dropped about $250 million or 50 percent during the 1990s.

The specific interpretations of these observations reside in the chapters in part II and in the status and trend reports. Of interest here is the general result that some changes were greater than expected and others less. A noticeable range exists in the strength of evidence with which conclusions can be drawn (discussed in chapters 5-10). This range is attributable to the nature of available information and how it was evaluated.

Recent scientific developments add to our understanding of Plan assumptions, and help to interpret Plan implementation (table 3-2). Most notably, ecosystem complexity and dynamics, both social and ecological, are emphasized in many studies. We also see some surprises, such as unanticipated mechanisms associated with changes in owl and fish populations. Some of the unexpected changes—such as new industry and community strategies—appear to be adaptations to the Plan. These findings are discussed in detail in part II chapters. Later, we look across the findings to seek emerging themes that might apply to the Plan as whole, rather than to individual Plan elements. Before we try to draw many conclusions, we next place these findings in a broader, longer-term context.

Interpreting the Evidence in a Broad Context over the Last 50 Years

Changes, whether induced by the Plan or other factors, are best understood when placed in the context of the large physical, biological, and societal complexity of Pacific Northwest landscapes, and by looking at the changes over time frames longer than 10 years. Some of the spatial complexities are captured in the maps depicting older forests (Moeur and others, in press, fig. 10) and census data (Charnley and others, in press b fig. 2-5. We graphically examine available data to look for trends in the 40 years leading up to the Plan compared to trends observed in the Plan decade (fig. 3-1, 3-2). We examine these graphs to see if longer-term trends separate themselves from the noise of short-term variability.

National trends and within- and between-state migration in human population are known to drive many factors that influence management direction on federal lands (fig. 3-1a). Increased human presence in the wildland interface has increased demand for water and recreation and has increased the danger and costs of controlling wildfire and hindered reintroduction of low-intensity fire. Because managing federal lands has been ground-zero for a societal debate over how these resources and values are collectively met, forestry has been elevated to the national political debate in recent decades. The volatility of social and political change (fig. 3-1b) makes long-term planning a challenge.

Examining all of these graphs together, shows some interesting disconnects. For example, U.S. housing starts, although quite volatile, do not increase with U.S. population or decrease with Northwest harvest—no long-term trend is observed over the 50 years of data (fig. 3-1c).

Wood production from federal lands fluctuated moderately from 1960 to 1990, with only a small long-term declining trend (fig. 3-1d). The subsequent steep decline started just before the Dwyer injunction,[ix] well before the Plan was implemented. Wood production by forest industry had little short- or long-term fluctuation until the mid 1970s. Industry harvest declined from then until about the start of the Plan in 1994, and then leveled out during the Plan decade. The stumpage value of harvested Douglas-fir spiked after the Dwyer injunction and then began to decline during the Plan decade, but remains well above historical prices. A major change occurred in the stumpage-price curves—previously large-diameter logs were worth 2 to 3 times more per unit volume than medium-diameter logs. This premium has disappeared, apparently because of increasing demand for small logs being processed in new, efficient mills and loss of mills able to process large logs. Short-term variability in lumber and wood-products jobs (fig. 3-1e) is smaller than variability in harvest or housing starts. Jobs were relatively steady up to 1980 and then began declining. The jobs per unit of harvest actually increased starting in the late 1980s and remains at a 50-year high. Economists think this increase came from increased mill efficiency, the loss of the log-export markets, and the associated increases in local manufacturing (see chapter 5).

The trends in owl populations[x] (fig. 3-2a) and late-successional old-growth forest, both major indicators for gauging progress, are mixed. Owl populations showed both continued declines and stable populations depending on differences in underlying factors and physiographic region. The areas of older forest are stable to expanding, and expectations are for continued increases (see chapters 6 and 7). The decisions not to cut as many older stands in the matrix as the Plan had called for, and to focus more on thinning plantations, yielded a double benefit to late-succession-dependent species—fewer large trees were cut and small-tree growth was accelerated.

Tree harvest (not counting thinning in plantations) was nearly stopped on federal lands during the Plan decade. Although aquatic specialists perceived that watersheds are generally in a poor state, cumulative harvest in riparian zones leveled off to about 5 percent (based on a sample of 250 watersheds; Gallo and others, in press), and a small number of riparian roads were decommissioned. The quality of aquatic habitat, defined by these factors, therefore improved in the 1990s. Issues arise with a more in-depth analysis (see chapter 9). For example, although direct funding for road maintenance has remained fairly steady, lack of surface replacement funds from timber sales resulted in an estimated 70-80 percent shortfall in needed resources for basic maintenance.[xi] Unfortunately, no long-term data on fish populations are available in the Plan area to verify that habitat and populations are empirically well linked. The closest, most reliable data come from the Carnation Creek study on southern Vancouver Island (fig. 3-2c), where fish were monitored before and after 41 percent of the watershed was harvested.

Clearly, returning salmon populations have high short-term variability making trends difficult to discern. As more is learned about controlling mechanisms and their interactions and variability—including ocean conditions—the emerging story is that stressors and populations are highly dynamic so that fluctuations cannot be attributed with much confidence to single causes, such as forest harvesting (Tschaplinski 2000). Extrapolating the Carnation Creek evidence (significant negative correlation of tree harvest to returning chum; little correlation to coho) across entire regions is likely further confounded by the type and extent of harvest, the local geomorphology, and many other factors. Research and monitoring may help us to better understand these assumptions and better anticipate new mechanisms, such as in-stream food availability, long-term disturbance effects, delayed effects, and factors limiting salmon during population dips. A network of more controlled management experiments, with aggressive treatments and taking perhaps 20 years, is likely needed to substantially improve our understanding to better manage these resources. Many partners will be required and institutional barriers overcome to accomplish this task.

The federal-land acres in Oregon and Washington that were burned in wildfires increased dramatically the early 1980s—relative to the 1960s and 1970s—although the number of fire starts appears reasonably steady (fig. 3-2d). The recent increase in wildfire is widely thought to result from fuels accumulation, caused in part by fire exclusion (see chapter 6). A broad look at the wildfire evidence provides insights into the difficulty of associating change with specific management actions. For example, interpreting the disconnect between starts and area burned is obscured by the interactions of increased fuels, weather, ignitions, and fire-response capacity. Although the average acres burned during the Plan decade increased, compared to the decade before the Plan (1985 to 1994), the confidence intervals around these averages strongly overlap.[xii] When the historical record is extended from 1954 back to 1916, new conclusions emerge, such as that recent wildfire acres are actually less than that observed from 1916 to 1945 (fig. 3-3). Thus, although fire exclusion appears to be strongly related to reduced wildfire before the 1980s, current rates do not match historical rates (1916 to 1945); but this conclusion has additional uncertainty. Wildfires in the first 15 years of the century in Oregon and Washington have been reported to be quite low (although the data are less certain), and changes appear related to shifting climate—leading climate modelers to theorize that wildfire is driven substantially by climatic shifts (McKenzie et al. 2004). The distribution of wildfires may be shifting as well. Although wildfire rates are close to that expected for the entire Plan area, most of the fires were in the drier Provinces (see chapter 6).

The only data we found that reflects the long-term capability of agencies to carry out the complex directives of the Plan were budget and personnel data dating back to 1990 (fig. 3-2b). Reductions in FS personnel were steep, and began some time before the Plan started. Numbers of BLM personnel were much more stable. These changes in capacity are likely related to the other changes (Charnley and others, in press b), but evidence of direct connections are difficult to find.

Some patterns under institutional control (for example, FS employee numbers) appear to have less short-term variability than market-driven factors like stumpage

price. Patterns influenced by the broader economy, such as housing starts, harvest on industrial lands, and wood-products jobs have intermediate variability. Patterns influenced by natural processes, such as fire, ocean condition, and animal populations appear most variable. People's lack of control over dynamic natural processes will continue to challenge institutions.

Patterns in some outcomes clearly rise above the inherent noise of their short-term variability, but few can be cleanly linked to the Plan itself. Looking at these patterns together, eight changes are most notable (table 3-3). Other smaller changes are clear, but perhaps no less important. The perspectives gained from available long-term data and their interplay suggests that the Plan is but one of many interacting processes at play. Because of the complexity and uncertainty, linking most outcomes to the Plan will take more than monitoring Plan outcomes.

Considering Other Issues and Emerging Perspectives for the Next 50 Years

Our review of regional monitoring and recent research was not intended to be comprehensive, or to provide much information about emerging issues. So next, we seek to make monitoring more useful to future management direction by interpreting the results from monitoring and research, in a broad context (above), to reveal crosscutting perspectives (below).

Our Evolving Understanding of Science-Based Management

The Plan in the past decade has often been looked upon as a model for large-scale ecosystem management (see Busch and Trexler 2003, Johnson and others 1999, Sexton and others 1999), and it will likely continue to do so. Specifically, the Plan has influenced discussions on the role of science, the role of assessments covering broad geographic areas, sustainability of ecological and social processes, and the need for multijurisdictional and adaptive-management approaches. We hope the experience we are describing in this 10-year interpretive report continues to contribute to the broader debate. In this section, we examine how the experience with the Plan has shaped our understanding of some of the issues surrounding managing complex ecosystems.

Role of federal lands—

Keeping changes on federal land in a holistic ecosystem perspective is important. For example, Oregon published a state-of-the-environment report (Oregon Progress Board 2000), where they concluded that:

> The greatest opportunity for improving Oregon's environment in this generation occurs on lands that Oregonians control: on state, county, and private lands. Much of what potentially can be achieved on federal lands is already reflected in new policies and plans for managing forest and range lands. Private lands have become increasingly important to solving many of Oregon's environmental problems for this generation.

Placing the federal lands in context with private timberlands in meeting Plan intentions is also important. The impression that federal lands can solve the significant issues that led to the Plan is false. Federal lands are only part of the solution towards achieving broad societal goals such as conserving biodiversity, maintaining forest productivity, or maintaining (and enhancing) socioeconomic benefits to meet societal needs (table 3-4). New cooperative relations between federal and other landowners might be expected in the future.

Many people believe that Oregon, Washington, and northern California have a better state of the environment than many other states or countries around the world. Thus, one interpretation is that the federal lands in the Pacific Northwest represent the best of the best. “Saving the best” is a legitimate approach, albeit perhaps with different consequences than “fixing the worst.”

Complexities of multiple scales—

The evidence from monitoring and research affirms that ecosystems are changing in complex ways and are rarely constant in time or space. The area covered by the Plan—established to follow the range of the northern spotted owl—includes 12 distinct provinces classified by their differences in climate, vegetation, geology, and landforms. Designers of the Plan recognized this variability and included options for modifying standards and guides even as they attempted to develop regional direction for the sake of efficiency. One of the Plan’s biggest challenges was and is how to implement a regional vision, one local project at a time. Several issues deserve discussion.

Midscale transitions—

In reviewing the Plan's first decade, we have observed some potential gaps in the spatial scale of planning and activities. For example, many acres were thinned to meet regional needs such as habitat, fuel reduction, and timber production, but how much landscape thinking went into those activities is not clear. Many important ecological and social processes are only important at the middle scales of provinces, larger watersheds, and diverse landscapes; for example, in dry provinces, meeting owl habitat needs and reducing the risk of high-severity fire. Midscale analyses are intended to help make the transition between scales, by being more spatially explicit and more site specific than regional plans. Midscale analyses could also play a role in defining monitoring needs at this scale, helping to develop a hierarchy of information. The opportunity exists to make the next round of forest and resource unit plans facilitate both management and monitoring activities across this hierarchy.

Site specificity—

Substantial knowledge of local conditions and the flexibility to respond to this understanding are not optional in multiscale management. Regional standards and guides—for example, 10 down logs per acre—enforced everywhere fail to take advantage of the considerable knowledge of local agency-specialists. Local adjustment processes (for example to change riparian buffers and to allow active adaptive management) had mixed success for a variety of reasons. Site specificity is not possible without such processes. The concept of site specificity is highly developed in silvicultural research and practice. It was recognized early on, for example, when Hawley (1921), discussing reasons so little was known about silviculture, noted that, "... silvicultural practice is essentially a local consideration, varying in important details from forest to forest." This observation remains true today. Scientific inference to complex goals across complex terrain remains quite limited. For example, research ecologists often develop general hypotheses and can rarely test them in many locations, and research silviculturists have a tradition of testing hypotheses in locally unreplicated blocks, often on accessible, gentle terrain. Only the local agency specialists can think about how well these ideas will work in specific sites. Multiscale managing could come to terms with this disconnect. We are concerned that sharp reductions in field personnel may limit understanding of site specificity and hence the successful merging of general principles with local knowledge.

Challenges of managing complex systems with simple rules—

One of the biggest challenges of ecosystem management is the complexity of its application. The uncertainties arising from multiple dynamic processes playing out over an initially variable landscape are large, and cannot be easily dealt with by overly simplistic strategies developed to be efficiently applied. The concepts of land-use designation, boundaries, and best practice are involved.

Dynamic forests and fixed management boundaries—

When the FEMAT options were developed, scientists knew that the landscapes of the Pacific Northwest were dynamic at all scales. Incorporating this dynamism into a 100-year plan with mapped land-use designations was a major challenge. Many old-growth forests in the region required centuries without high-severity fire to develop, and some others required low-severity fire every 20 years or so. Although fixed land-use designations—reserves and matrix—formed the basis of the Plan, the hypothesis was that Plan goals could be met despite the disturbance and succession that would alter the structure and composition of the forests in those designations. The Plan anticipated that silvicultural activities were needed in many of the biodiversity-oriented reserves (80 percent of the federal lands), as well as the timber-production-oriented matrix lands (20 percent of the federal lands). The chosen boundaries were strongly influenced by the patterns of existing older forest, but also by a vision of a future, altered distribution of forest conditions, designed to better meet Plan goals. This reserve-matrix strategy has not been tried before at this scale; thus, the long-term success is by no means assured. Continuing to evaluate the strategy as well as reasonable alternatives to it would be wise. Based on only one decade of evidence from monitoring and other sources, we cannot say whether a different spatial arrangement of reserves and matrix would have been more or less effective. We also cannot say with confidence, at this point, whether another management option—such as FEMAT option 1 or 5—would have produced a different outcome. Given the large Plan area, and slow changes in forest conditions, alternatives that may result in different outcomes at 100 years may appear relatively similar in the early decades.

Midscale assessment of the consequences of the current pattern of reserves and matrix allocations—where changes to boundaries or activities in designations were considered—was rare, so far, while the Plan was being implemented. Given the threats from high-severity fire, insects and disease, and uncertainties about reaching desired outcomes in the dry provinces, we see reasons to reexamine the midscale designations in these provinces, not only from the standpoint of boundaries, but also from the perspective of the kind and intensity of active management needed in all land-use designations to better reach the goals of the Plan. This debate includes the boundaries of adaptive management areas. Should these boundaries change in response to their effectiveness or changing ecological or social conditions? The areas were chosen for a variety of reasons, not strongly considering regional and local institutional capabilities or how well they represented broader areas (Stankey and others 2003a). Some of the more successful adaptive management projects happened outside of the adaptive management areas (chapter 10).

With few differences between how reserves, matrix, and adaptive management areas were implemented, whether land-use designation makes sense seems to be an appropriate question. Perhaps a strategy that just sets goals for protecting old forest and providing some commodity production for local communities, without drawing lines on a map, would have been equally effective—assuming that society could grant this much flexibility to federal agencies.

Challenges of managing under high uncertainty—

When all of the evidence is examined, several questions come to light: How well do we know and can we know these systems? How well can we attribute the various outcomes to the Plan itself, or for that matter to the Plan's implementation? How can planning and managing respond to large uncertainties?

Across all perspectives, evidence of uncertainties (and their effects) is considerable:

- Spatial variability in the Plan area is known to be large, driven by variation in geology, climate, biota, elevation, and disturbance history (see Moeur and others, in press fig. 10), which is why physiographic provinces were created by the Plan;
- Monitoring and other evidence exposed large year-to-year variation in owl and salmon population estimates, wildfire acres, stumpage prices, and ocean conditions.
- Some outcomes were surprises, such as owl population shifts, a 500,000-acre wildfire, various lawsuits, changes in the stumpage-price curve, loss of the export markets and industrial infrastructure, community adaptations, retiree relocations, and major FS employee and funding reductions.
- New mechanisms were hypothesized in various chapters, including effects of barred owls and wood rats on spotted owls, different watershed dynamics in larger watersheds, and ecological importance of disturbances and native, early-successional pioneers.
- More complexities were recognized, such as large local variation in fire history, and the need to treat mixed-severity regimes differently.
- Unforeseen future trends also came to light, such as long-term changes in seral stage distributions, not recognized before (chapter 6).
- Improvements in habitat models were not sufficient to substitute for direct monitoring of population changes.

- The effects of climate change on species and ecosystems in the next decades are potentially large, but also uncertain.

The conclusion that uncertainties are high is supported by recent developments in ecology. Ecologists are increasingly stressing the uncertainty associated with ecosystems and their dynamics (Hubbell 2001, Lande 1991, Lemons 1996, Ludwig and others 1993, Shaffer 2000). As a consequence, both scientists and managers have to contend with uncertainty more than ever and, perhaps, more than they would like. Implications extend to the Plan (Bormann and Kiester 2004).

Clearly both FEMAT (1993) and the Plan authors recognized high uncertainty in the assessments themselves by invoking adaptive management, adaptive management areas, monitoring, and riparian adjustments as ways to change course as more was learned. Implementing this strategy to respond to uncertainty, however, showed mixed results (chapter 10). Thus, reflections on the magnitude of uncertainties and how to implement strategies to respond to them are both needed. This debate is not limited to forestry. For example, the business management literature uses a term "environmental uncertainty" (extent of unpredictable changes in the external environment, Buchko 1994). A major debate continues on the need for changes in strategy and planning when companies face high uncertainty, such as shifting international trade and manufacturing patterns (Galbraith and Kazanjian 1986). The theory states that decisionmakers operating in highly uncertain environments will adopt a planning process consisting of comprehensive data collection, systematic data evaluation, and decisionmaking based on analytic outcomes, and managers operating in predictable environments are more likely to rely on experience (Dean and Sharfman 1996). Forest management under the Plan is clearly based on substantially uncertain ecological and social processes; thus, new approaches to planning may be needed to better adapt to changes. The business model suggests that planning could be better based in adaptive management, monitoring, and evaluation closely linked to decisions. Agencies appear to be starting down this path.

In this uncertain environment that Plan implementers are managing in, how they respond to uncertainty is more important than how much uncertainty exists. We offer two strategies to consider: improved, systematic adaptive management and monitoring; and diversified practice.

Systematic adaptive management—

In many attempts under different conditions, adaptive management often is disappointing (Walters 1997). The Plan efforts are largely no different (chapter 10). The institutionalizing of regional monitoring, the adaptive management cycle and this mandated, 10-year report does, however, represent major steps forward. Adaptive management was viewed as a cornerstone of the Plan, largely as a mechanism to deal with recognized uncertainties. No alternative to moving forward with developing and implementing an improved adaptive management and monitoring system has emerged. A systematic and fully institutionalized approach could make plan implementation more dynamic by increasing the rate of learning through a balance of regional monitoring and management experiments on or off the adaptive management areas (fig. 3-4). A systematic approach could be driven by a small set of corporate questions, geared to focus learning activities, and periodic interpretive steps to integrate disparate knowledge sources in broader and longer-term perspectives. Monitoring, management experiments, and periodic interpretation steps would be driven by forward-looking questions because of the time needed to detect changes in complex forest systems. Annual interpretative workshops could help institutionalize adaptive management and respond to the dynamic nature of our understanding by considering changes in approaches to better meet longer-term learning objectives. The path is clear, to move from opinion-based toward evidence-based interpretation of the vital questions about federal forest lands. We can be optimistic, with strong leadership and a professional focus, that adaptive management can be implemented to bring together managers, regulators, researchers, field specialists, and multiple constituencies in a more constructive dialogue than the current debate. Adaptive management and associated monitoring can be refocused on preparing for future interpretive reports by refining the questions future managers may face.

Best practice box

Diversified practice—

A concept not well appreciated in early versions of ecosystem management is diversifying approaches to spread risks. The concept of diversified practice in response to high risk and uncertainty is simple on the surface: just don't put all your eggs in one basket. Why diversifying is important and how to apply it are much less clear. Putting all eggs in one basket is a risk especially where outcomes are fraught with surprises. Diversified investment portfolios also help illustrate the problem—successful portfolios spread the risk of failure across fundamentally different investments (such as stocks, bonds, and real estate), so that if one type of investment fails another is not likely to follow, thus evening out large fluctuations. Thus, risk is lessened in forest management when multiple valid approaches to achieving an objective are simultaneously applied. Risk tolerance can be expressed by allocating space to various approaches, which in turn affects the magnitude of the gains and losses. Diversification does not mean adding new objectives in a land-use designation to be achieved by a wide variety of approaches; nor does it insist that widely unacceptable approaches be included. It simply means that the uncertainties are often high enough to warrant trying multiple creative approaches at the same time in the same land-use designation. The Plan did not prohibit such variability; the Plan also did not encourage it. Clearly, this new paradigm will need to overcome best-practice inertia, and will need to be clearly articulated to regulatory agencies and the courts.

Importance of planning language—

During the 1990s, we have seen concepts and associated terms developed by scientists used generically in societal debates about natural resource management. What scientists often thought to be technical issues became determinants of public opinions. As all concepts mature, many definitions gain clarity; some remain ambiguous by design; and some appear misleading. Herman Daly speaks about the roles of vagueness and clarity in language (Daly 1996):

> While not vacuous by any means, the [World Bank] definition [of sustainable

> development] was sufficiently vague to allow for a broad consensus. Probably that was a good political strategy at the time—a consensus on a vague concept was better than a disagreement over a sharply defined one. By 1995, however, this initial vagueness is no longer a basis for consensus, but a breeding ground for disagreement. Acceptance of a largely undefined term sets the stage for a situation where whoever can pin his or her definition to the term will automatically win a large political battle for influence over our future.

Here, we examine how some terms have matured and how they may affect the future of the Plan.

Comment: Gordon suggests citing the JoF issue on this

"Old growth" is no longer just a forestry or ecological phrase—it has grown into a highly value-laden phrase. Some of the more recent uses—forests that lack a history of management and forests with trees older or larger than trees found in plantations—now have little scientific basis. At the same time, forest ecology has advanced to recognize the complexity and variability in all forests, including old growth (see chapter 6). The older forest monitoring module (Moeur and others, in press) accommodated multiple perspectives by analyzing a range of potential definitions. This step is important in facilitating a more informed and connected debate.

Management objectives have sometimes included ambiguous terms to describe intent and rationale. We have seen this practice backfire during the first decade of the Plan. "Forest health" was cited as the major need in many EISs implementing the Plan on matrix lands, rather than timber production (for example, on the Eagle Creek EIS in 1996 on the Mt. Hood National Forest; Franklin and others 2001). Forest health, to agency silviculturists, meant thinning to reduce insects and disease, perhaps fuel loads, and to promote growth of residual trees; it meant natural progression toward older forest to some people; and others thought a healthy forest was one without human intervention. The lesson, however, is by using “restoring forest health” as a cover for Plan-directed timber harvest in the matrix is not acceptable to the public. We suggest that simple direct language will also help us to write better, shorter NEPA documents that clearly explain proposed direction by connecting rationale and evidence to decisions.

The phrase “adaptive management” was used extensively in the Plan with varying perceptions of success, including some critical reviews in the scientific literature including titles like, **Adaptive management: rhetoric or reality** (Stankey and others 2003a). Much of this variation arose from the lack of effort to forge a common definition or understanding of the concept. That monitoring and adaptive management were considered separate activities initially points to conceptual confusion as well. We sought to more clearly portray a vision in the adaptive management and monitoring (chapter 10). More work is ahead.

The term “reserve” was chosen in the Plan to describe late-successional and riparian land uses that included some active management. Confusion arose from at least two sources. Reserve was not used to describe the matrix allocation or the adaptive management areas where even more-active management was planned. Reserve also sounds a lot like preserve, often used in association with wilderness and park lands. The term has a long and varied history and is now defined by international consensus to encompass both active and passive management (see chapter 6). Changing to a name without a double meaning would not be sufficient, without the effort to clearly define and widely articulate what the land-use objectives are.

Lastly, we would like to clear up what is meant by the "Plan." To the public, much of what we describe sounds like a single overarching document that sets the context (and direction) for managing federal forest lands. But land management planners taking a NEPA-centric approach argue that no single plan exists; rather, it is a document that amended 24 forest and district plans.[xiii] This view suggests that we take care in how we represent future planning efforts if we want to avoid conflict with broader public perceptions.

Issues of trust—

The implementation of the Plan has been slowed by a lack of trust between various publics and land managers. Mistrust arises from questioned intentions, lack of clarity and unwarranted certainty in the debate, and differences between promises made and promises kept. Other forms of mistrust are more rooted in beliefs and social discord. People often have difficulty accepting the intent, objectives, or approaches presented by polar groups. Some of the adaptive management areas were able to assemble diverse stakeholder groups and, through personal interaction, come to consensus on controversial projects that were then opposed by national organizations (Stankey and others 2003b). Trust has a difficult scaling dimension—trust is or is not given at multiple, sometimes independent scales.

Key in this next decade is attending to the factors and processes that can enhance trust between and among people and organizations (Stankey and others 2003b). In the science community, we need to avoid presuming that trust is equivalent to high statistical confidence and association. On the management side, consider how trust can contribute: to developing and implementing land management plans, to helping groups (networks) form, to engaging them in the process—including assistance in defining the range of acceptable options and the basis of compromise—and to developing public understanding and support. This last aspect is critical because, as Stankey and others (2003c) have argued, without public understanding and support, the political legitimacy and capacity of management agencies to act effectively is in doubt.

Uncertainties about ecological and social processes and institutional capacities could be articulated more openly and clearly than in the past—in planning and decision documents—to manage expectations; a range of outcomes would often be more in line with what is known. Convincing people that managing ecosystems for complex resource objectives has considerable uncertainty should not be difficult; after all, if a plan—as ambitious and complex as this Plan is—has never been implemented before, why should people expect great certainty in whether it will or will not work well? Building institutional capacity focused on learning that connects to multiple constituencies may be an important way to build trust. This trust building appears to be happening in the Five Rivers project on the Siuslaw National Forest. After a 12,000-acre management experiment contrasting ways to manage plantations to achieve late-successional and riparian objectives was enjoined, along with many other projects in coastal forests in 1997, the environmentalist plaintiffs, after learning of the project, asked the court to remove it from the injunction, and the court agreed—even though substantial commercial timber volume was to be sold. Forest industry interests have also enthusiastically supported the project even though it includes significant areas where thinning will not be allowed. Whether such trust-building can happen at larger scales remains unclear.

Bringing Science and Management Together

Integrated management strategies—

Any interpretation of monitoring results and new science cannot be applied without some concept of potential future directions managers may take. The role of science here is to inform decisions about those directions. Here are several examples of possible future direction, mainly to illustrate how science and policy may be integrated. But first we need to recognize again that science is only one factor influencing decisions about where to take the federal lands. Many people think the Plan is about saving old growth while maintaining lower timber harvests. A careful reading of the original list of the President's principles suggests a more complex set of goals, including economic, ecological, legal, intergenerational, organizational, and perhaps even emotional elements:

- Never forget the human and the economic dimensions;
- Protect the long-term health of our forests, our wildlife, and our waterways;

- Be scientifically sound, ecologically credible, and legally responsible;
- Produce a predictable and sustainable level of timber sales and nontimber resources; and
- Make the federal government work together and work for you.

The national forests and BLM districts are expected to provide recreation, aesthetic landscapes, hunting and fishing opportunities, firewood, wilderness, special forest products, and many other values not addressed explicitly in the Plan but specified in forest and district plans. Legally, the Plan is an amendment to these plans that seeks to deal with a limited range of societal objectives thought to be met only through regional oversight.

Managers understand that scientific information is rarely well integrated in support of their complex management objectives. Fragmented knowledge coming from different disciplines may lead to artificially fragmented approaches, each geared to a specific problem. Managers of federal lands respond to meet multiple public values, but values cannot be efficiently addressed one at a time. Management efficiencies can be found when multiple values can be met together, though not necessarily at the same time or place—which is easier said than done.

> IN EFFECT, MANAGING FEDERAL FORESTS CAN BE THOUGHT OF AS A STRATEGY OF STRATEGIES, SEEKING TO MEET A BLEND OF SOCIETAL OBJECTIVES BY APPLYING THE BROAD SCIENTIFIC UNDERSTANDING

OF HOW TO ACHIEVE THOSE OBJECTIVES COMBINED WITH LOCAL ON-THE-GROUND EXPERIENCE AND KNOWLEDGE, AND WITHIN INSTITUTIONAL CAPACITIES AND CONSTRAINTS. FLEXIBILITY IS THE KEY BECAUSE ALL OF THESE FACTORS CHANGE THROUGH TIME. THE CHAPTERS ON POLICY CONTEXT, SOCIOECONOMICS, AND ADAPTIVE MANAGEMENT TOUCH ON SOME OF THE COMPLEXITIES AND UNCERTAINTIES OTHER THAN THOSE ASSOCIATED WITH SCIENTIFIC UNDERSTANDING OF FOREST ECOLOGY. THE DYNAMICS OF THESE SOCIAL PROCESSES HAVE STRONG SIMILARITIES WITH THE DYNAMICS OF ECOLOGICAL PROCESSES DISCUSSED IN THE OLDER FOREST, SPECIES, AND AQUATIC CHAPTERS. THE FULL APPRECIATION FOR THE DIFFICULTY OF THE JOB IS UNDERSTOOD WHEN THE INTERACTIONS OF ALL OF THE SOCIAL AND ECOLOGICAL PROCESSES ARE COMBINED.

EXAMPLES OF INTEGRATED APPROACHES—

WE DEVELOP AND DISCUSS A RANGE OF POTENTIAL APPROACHES TO PRESSING ISSUES, TO THINK ABOUT HOW SCIENCE AND POLICY MIGHT BE BETTER INTEGRATED. THESE APPROACHES ARE NECESSARILY VAGUE AND INCOMPLETE; OUR DISCUSSIONS ARE NOT A SCIENTIFIC ASSESSMENT OF THEM. THE SCENARIOS SIMPLY PROVIDE A WAY TO THINK ABOUT THE INTEGRATIVE PROBLEMS MANAGERS FACE. THE DISCUSSION REPRESENTS THE KIND OF DEBATE THAT WILL LIKELY LEAD TO WISE POLICY.

Salvage logging in late-successional reserves—

Salvage logging in late-successional reserves—a contentious issue while implementing the Plan—is a good example of the complexities of the science-policy interface, and the limits to which science can guide management. The Plan allowed for "some" removal of dead trees from late-successional reserves to meet additional non-ecological objectives (USDA and USDI 1994b):

> Salvage guidelines are intended to prevent negative effects on late-successional habitat, while permitting **some** commercial wood volume removal. In some cases, salvage operations may actually facilitate habitat recovery. For example, excessive amounts of coarse woody debris may interfere with stand regeneration activities following some disturbances. In other cases, salvage may help reduce the risk of future stand-replacing disturbances. While priority should be given to salvage in areas where it will have a positive effect on late-successional forest habitat, salvage operations should not diminish habitat suitability now or in the future.

With our current state of knowledge, ecological science cannot help much in determining what "some" means and in determining at what rate or extent salvage removal would diminish habitat suitability (see chapter 6). For example, although we know that large dead trees have many ecological functions in post-wild fire stands (Lindenmayer and others 2004), we can not predict how species composition and ecosystem function will change over the long run when only some of the commercially valuable dead trees are removed, leaving various amounts of snags and downed wood. Furthermore, only managers can decide how to weigh the tradeoffs between the uncertain ecological effects and known economic benefits of commodity production from salvage logging. The issue is further complicated by the fact that timber receipts from salvage logging FS land can be used for other fire recovery efforts, such as planting, replacing culverts, restoring trails, reducing fuels, and monitoring. A guiding principle of the Plan was to provide for legally sufficient protection for species and ecosystems and, having done that, to provide for economic and social well being. This tradeoff was well specified in the ROD, by designating reserves and matrix. Only a few situations remained where managers had some options for additional weighing of ecological and economic values—salvage logging in late-successional reserves is one of them. The pro- and anti-salvage arguments—articulated by different groups of researchers after the Biscuit fire (for example, Sessions and others unpublished)—reflects the scientific uncertainty, multiple interpretations of Plan nuance, and disjointed societal mandates.

We see opportunities for incorporating more science into these decisions, nonetheless. We start by suggesting that learning about post-fire management on late-successional and riparian reserves is important, given the uncertainties in how systems will respond to salvage over the long term. Risks of serious flaws in thinking suggests that rigorous comparisons be made between areas not salvage logged, allowing natural processes to unfold; areas with some salvage logging, attempting to speed older-forest recovery and pay for associated actions; and areas trying innovative strategies, for example prescriptions with frequent underburning. Large fires present an opportunity where, by applying active adaptive management (chapter 10), enough initially similar lands can be found for replicating these comparisons. We also see many important research needs, to retrospectively reassess responses of forested landscapes to past fire and salvaging, to explore the effects of disturbance on long-term productivity and biodiversity, and to study poorly understood patterns and processes like the long-term roles of wood and pioneering and invasive plants.

Managing fire-prone forests—

The older-forest and species chapters present a rationale for substantially increasing and repeating fuel treatments over large areas in the drier parts of the Plan area, as a way to maintain important habitat. A new fire regime (mixed severity) has been identified, and studies have shown that fire histories are more related to local terrain, vegetation, and climate than thought before. The Plan has mixed messages about how to prioritize fuel reductions on one hand and maintain owl habitat and avoid ESA-defined losses (take) on the other, and different scientists emphasize different messages. An active scientific debate is ongoing about the best ways to reduce the spread of severe fire over diverse landscapes. Managers are left with multiple understandings from science, multiple interpretations of Plan language, and not much on-the-ground experience applying frequent low-intensity fire in these forests. They are also left with the reality that funds to reduce fuels are lacking, and court rulings are unpredictable. And they are presented with national priorities to reduce dangers to local communities, as well as to meet other regional and local priorities. Again, the decisions managers make are only partly based on the science. The feasibility of managing fire-prone national forest lands lies, in part, in whether revenues can be generated in thinning sales to pay for uneconomic thinning, mulching, underburning, planting, and other needs. A major challenge in learning how to reintroduce frequent, low-intensity fire also exists, as does finding alternatives in areas where smoke violates the Clean-Air Act. Potentially disconnected needs also require attention, such as maintaining roads and access for economic fuel reduction and for fighting future fire—and decommissioning roads to improve riparian habitat.

We see opportunities to reinvigorate multiscale analysis and management to approach this problem. Multiple interacting objectives are involved, such as protecting life and property, facilitating control of future fires, maintaining suitable habitat for owls and other species, facilitating recreation and hunting, increasing local employment, improving aesthetics, supplying firewood, and many other multiple-use objectives detailed in the local forest or district plans. Multiple interacting patterns and processes are also involved, such as current vegetation; variance in fire regimes; distributions of habitats, populations, and roads; places where backfires might be set; other disturbances; and invasive plants, to mention a few. Each of these objectives and factors scale differently. Multiscale analysis could be developed to examine tradeoffs across the full multidimensional objective-process space. Midscale analyses are central because most tradeoffs are between the regional and local scale. Midscale analyses are intended to help make the transition between scales by specifying approaches for sites to best meet broad-area objectives. Results from regional assessments could be incorporated into midscale analyses to provide context and identify possible issues at this scale. With midscale analyses in the dry areas where the risks to maintaining the ecological functions of reserves is high, considering how the Plan land allocations might be modified to better deal with these highly dynamic landscapes may be necessary. Such modifications need to be considered in light of landscape management strategies and deviations from expected Plan outcomes.

New approaches to managing fire-prone forests could better accommodate the uncertainties identified. For example, in dry forests near towns where fuel reduction is a priority, a range of fuel reduction methods might be tried. Because these communities have real concerns for their safety, they may be more willing to get engaged in a management experiment to rigorously compare alternate methods that they can help to develop and implement. They may also oppose lack of action as one of the methods compared. Management experiments that only include alternative fuel-reduction methods, without a no-action method, will produce valuable information nevertheless. Fuel reduction trials would be a great place to involve the regulatory agencies as full partner in the design and monitoring.

Managing for a distribution of seral stages—

The Plan was created to solve the problem of declining old growth, with the underlying issues of owls and biodiversity in general. Recent projections suggest that, by 2050, older forests will occupy 75 percent of federal lands in the Plan area, up from 45 percent today (Mills and Zhou 2003). The consequences of widening gap in ecological condition are poorly understood. Natural disturbance regimes have been used to justify policies seeking to increase older forest on the landscape. Yet those same studies also indicate that landscapes in the Plan area were not completely blanketed by older forest (Nonaka and Spies, in press), in fact, many

areas were a complex of young and old forests, with the mixture varying across multiple spatial and temporal scales. As research on the owl in the southern part of its range suggests (Franklin and others 2000), landscapes with a blend of old and diverse early-successional forest may be better for native biodiversity than landscapes dominated by only older forests. Although private and industrial lands will likely continue to have a preponderance of young, managed plantations, diverse early-successional communities may become underrepresented. Vegetation management is very effective at shortening the time and space for pioneers, whereas natural succession often has a prolonged period when pioneer plants and their associates dominate. Many of these pioneer plants are known to control important processes affecting long-term soil productivity and biodiversity.

If a diversity of successional stages at broad spatial scales is desirable for maintaining native biological diversity, then the question becomes does the Plan provide for that diversity? Of course, natural disturbances, such as fire and insect outbreaks will create diverse early successional conditions in the Plan area. In the moist provinces and to some degree in the dry provinces, however, most high-severity fires will be suppressed and the amount of diverse younger forests may not achieve what would have been expected under a natural disturbance regime. Consequently, creating some of this diverse in early-successional forest through active management might be desirable. The Blue River study (Cissel et. al. 1999) is an example of an alternative to meeting the goals of the Plan where active management was used to create a specified distribution and spatial pattern of

successional stages across a federal landscape (this approach was actually intended to maintain mature-aged forest conditions and avoid a federal landscape with only young and old-growth stages). The state of Oregon is also trying to implement a variable-rotation-length approach that allows more timber production than on federal lands, while maintaining a portion of the landscape in older forest. A long-rotation approach, however, was initially considered by FEMAT scientists but rejected because of perceived high risk to terrestrial and aquatic species and ecosystems.

These different perspectives could be further developed into contrasting strategies that would be rigorously compared in large-scale management experiments. Involving people with different perspectives is essential and would allow creative approaches to coalesce and be seriously considered. We also see some opportunity to examine past management retrospectively to shed some light on these ideas.

Considerations

The current Plan course is the net result of the intersection of initial Plan objectives with the realities managers faced along the way. During the first decade of the Plan, we have concluded that the agencies did well, especially for biological objectives. Many expectations, for timber production and adaptive management might have been overly optimistic, and perhaps were somewhat unreasonable. Better managing of expectations in the next decades is important. Budget reductions for federal agencies—especially the loss of funds from FS trust accounts, often from revenues generated from timber harvests—led to major reductions in permanent FS employees, which influenced agency capacity. Perhaps a timber program is required to meet the many other important agency functions—like keeping records, maintaining roads, and even providing for recreation and wildlife. We are also concerned whether minimal capacities are being maintained, such as the on-the-ground knowledge of the forest. The main question in the near future may be whether the current federal workforce can carry out the complex management strategies set forth in the Plan, and if such a workforce cannot be assembled, whether a different approach is needed. In the last few years of the Plan, managers appear to be dealing with these problems more successfully, especially with increased thinning volume from plantations in coastal late-successional reserves and fuller funding of and attention to a fully institutionalized and integrated adaptive-management and regional monitoring program.

Science from monitoring and research does not lead to specific prescriptive solutions. The evidence and its collective uncertainties do suggest that we cannot know for certain that another approach (for example, one of the other FEMAT alternatives) would have done better or worse than the approach applied, which is not to say that all approaches work equally well. In general, we think the goals of the Plan cannot be met by returning to the timber harvest rates in the mid 1980s or converting the FS and BLM lands into de facto national parks. The historical harvest rates would have quickly cut most old stands and impaired critical habitat for important late-successional and aquatic species, and continue to be unsupportable by current case law. Eliminating commercial harvest from the federal lands would not be in the interest of the timber-dependent communities or others, especially in fire-prone areas or forests requiring considerable institutional or financial resources to meet other objectives. Our understanding of ecological and social processes, their interactions, and their collective uncertainties suggests that a range of middle courses exist that is reasonably consistent with what we understand about how these forest ecosystems work. Middle courses might be found, not by more science, but by developing a new, positive vision of how the federal forests can meet diverse societal goals, rather than focusing on meeting regional standards and guides. Improving adaptive management and monitoring, risk management, and record keeping can increase the effectiveness of these middle courses and provide a more solid foundation for connecting to the diverse constituencies in the region.

Table 3-1—Coalesced key short findings from Plan monitoring (see other chapters for details)

Indicator	10-yr expected[a]	10-yr findings[b]	10-yr deviation	Relevance to the Plan and its implementation
Older forests (FEMAT definition)	Maintain or increase (1.1% increase)	Slight increase (2.1% increase)	Rate of increase almost doubled	The Plan slowed old-forest harvest; implementing nearly stopped it (chapter 6)
Older forest losses from fire	Moderate (2.5%)	Dry provinces (1-9%) Wet provinces (0-1%)	Average (1.9%) near expected	Losses were mostly in dry Provinces, and fuel reduction was less than planned (chapter 6)
Realized owl populations in northern range	Slight to large decline (0.7-8.4% loss per yr)	Large decline (7.5% loss per yr)	High end of range	Declines may have resulted from habitat loss, barred owls, and other factors (chapter 7)
Realized owl population in southern range		Slight to no decline (2.0% loss per yr)	Low end of range	Owl use of brushy habitat appears important (chapter 7)
Plan-wide owl habitat	Slight decline (5% loss)	Little decline (1.3% loss)	Rate of decline less than half	The Plan curtailed habitat loss to harvest and more stands grew into larger size classes than were lost (chapter 7)
Plan-wide murrelet habitat	Conserve most remaining habitat	Little (2.3%) lost on federal lands	Near expected	The Plan slowed habitat loss and implementing curtailed it further, but other factors are likely involved (chapter 7)
Plan-wide murrelet populations	About a 35% decline	No change in 4 years	Less decline than expected	Ocean conditions and recruitment may explain unexpected stability (chapter 9)
Other older forest species	Maintain with annual review	Many new sites discovered and	Site protection as expected;	Survey & manage species program was phased out (chapter 8)

[a] Few well quantified expectations were included in the Plan. Here, we reconstruct expectations from various sources, including FEMAT and participant's recollections.
[b] Findings are derived from data in background monitoring reports.

		species protected	population trends unknown	
Watershed condition scores	Maintain or increase	60% increased, 39% maintained	As expected	The Plan curtailed most riparian harvest leading to desirable scores (chapter 9)
Road decommissioning	Unspecified	10 mi for every 1 mi built	Large ratio; low miles	The Plan decommissioned few miles of riparian roads (chapter 9)
Altered riparian boundaries	Many	"Very few"	Fewer than expected	Alteration mechanisms were inadequate for a variety of reasons (chapter 9)
Plan-wide timber production	Consistent supply (8.5 BBF)	Inconsistent, poor quality (0.5 BBF)	Much lower than expected	Implementing ran into various problems, including lawsuits and protests (chapter 5)
Timber production in matrix	8.5 BBF	<0.5 BBF	Much lower than expected	Harvest of older forest in matrix not implemented to any great extent (chapter 5)
Timber production in late-successional reserves	Allow some salvage logging	Thinning in some reserves	Higher than expected	Thinning in late-successional reserves made up for some of lost matrix harvest (chapter 6)
Community stability	Maintain flow of goods and jobs	Half changed; some declined	Large negative for some communities	The Plan had less positive or negative influence than expected (chapter 5)
Interagency and citizen collaboration	Improve relations	Agency-yes; citizen-yes	Agency-large; citizen-small	Interagency collaboration worked well in many, but not all, cases (chapter 5)
Adaptive management areas (AMAs)	10 AMAs providing changes to the Plan	Few active AMAs remaining	Much less than expected	As implemented, AMAs were insufficiently flexible or institutionalized (chapter 10)
Adaptive management process	Not well specified	A few projects outside of AMAs	Unknown	The process was not widely integrated into agency missions (chapter 10)
Regional monitoring	Not well specified	5 modules are functioning well	Near expected	Regional monitoring was well institutionalized and funded (chapter 10)

Employees-FS (as capability indicator)	Slight decline	Large decline (40-60% in OR NF)	More than expected	Plan goals hampered by sharply declining FS workforce (chapters 5, 10)
Employees-BLM	Slight decline	Slight decline	As expected	Capability was continued (chapter 5)
Manager-researcher collaboration	Improved at least on AMAs	Improved relations generally	More than expected	The Plan was more science based than before (chapters 5, 10)

Layout table two facing pages

Table 3-2—Key findings from relevant research studies

Post-Plan research findings	Chapter
Area of diverse early-successional forest will likely decline in the future with current strategies on public and private lands.	6
Diverse pathways of succession lead to older forest condition; a common one has low conifer densities at young ages developing into multi-aged stands with closed canopy at old age.	6
Definitions of old growth by scientists and society are changing and diverging.	6
Thinning plantations to move in the direction of older-forest habitat appears promising.	6
Successful adaptive management is generally rare in natural-resource management.	10
Active adaptive management at large scales, although rare, is possible with sufficient leadership and collaboration.	10
New approaches to public participation and adaptive management have evolved.	5
The importance of monitoring in facilitating productive dialogue about management possibilities was recognized	10
Aquatic systems are far more dynamic than has been realized; benefits from some kinds of fire and landslides are newly recognized in some systems.	9
A new, mixed-severity fire-regime is recognized; numerous older forests thought to be in high-severity regimes are now in mixed regimes.	6
Federal lands have a small proportion of the best coho salmon and murrelet habitat.	9
Barred owls may be replacing spotted owls, especially in the northern range.	7
Owls in the checkerboard lands in their southern range may have fared well because of adjacent, brushy foraging habitat.	7
Nonfederal lands have important regional effects in contrast to Plan assumptions.	5
The timber industry has adapted to changes, and some of the adaptations benefit regional employment (more manufacturing jobs per volume of wood processed).	5
Communities express different degrees of adaptability.	5
New kinds and magnitudes of complexity and uncertainty are recognized.	5

Table 3-3—Big changes in the last 50 years, descending in magnitude (from variables displayed in figs. 3-1 and 3-2)

Outcome	Observed change	Pattern as related to the Plan
Older forests	**Loss of older-forest stands in the last 5 years is less than 5% of the late 1980s peak losses.**	**The decline in loss began 5 years before the ROD was signed.**
Wood production	**Production in the last 5 years is less than 10% of the late 1980s peak.**	**Production is shifting to thinning of young stands in reserves.**
Wildfire	**Acres burned 1950 to 1980 were about 10% of what burned 1980 to present.**	**Long-term trends and variability obscure direct relation to Plan.**
Returning chum salmon, Carnation Creek	**Returns in the mid-1990s are about 20% of the mid-1970s returns.**	**The variability, location, ocean changes, and cutting intensity do not relate well to the Plan.**
Capacity, using FS employee numbers	**Forests now have 30 to 40% of the permanent employees in 1990.**	**The decline began at least 5 years before the Plan.**
Owl populations in Washington	**About 60% of owls are left, at present, compared to 1993.**	**No pre-Plan data are available to make any inference.**
Douglas-fir stumpage prices	**Prices before 1990 were about 65% of prices during the Plan decade.**	**Prices appear related to regional timber production.**
Regional wood-products jobs, all ownerships	**About 70% of jobs remain at present, compared to the peak in 1980.**	**A steady decline started in 1980 and continues through the Plan decade.**

Table 3-4—How older forests, habitat, and timber harvest are currently distributed between public and private lands on a percent area basis over the Plan area (see chapters 5 to 7)

Ownership	Older forests	High-quality owl habitat	High- quality murrelet nesting habitat	Timber harvest
	Percentage			
Federal and state	77	59	50	15
Private	23	41	50	85

Figure List

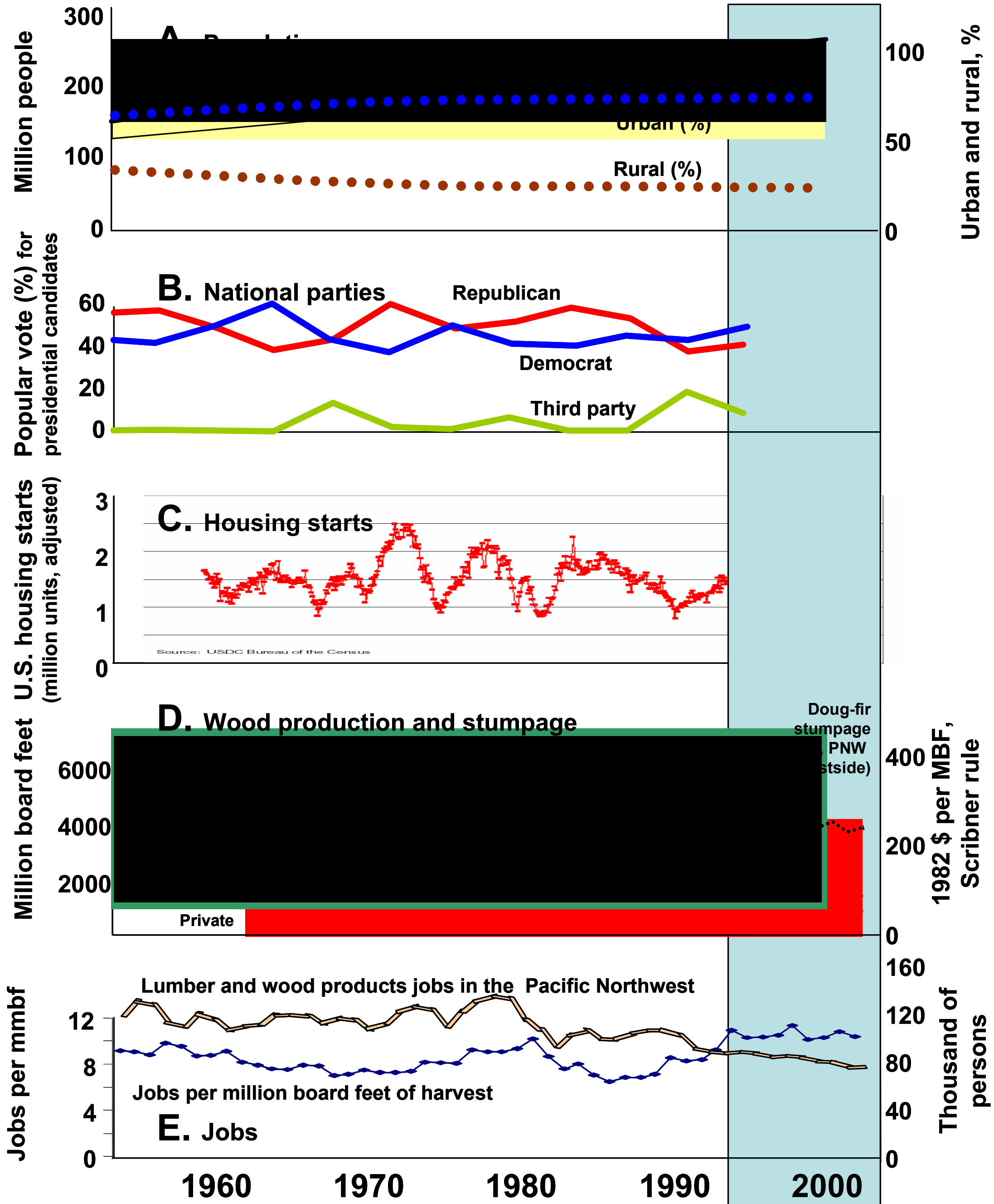

Million people
300
200
100
0
Rural (%)
100
50
0
Urban and rural, %
Popular vote (%) for presidential candidates
B. National parties
Republican
Democrat
Third party
60
40
20
0
U.S. housing starts (million units, adjusted)
C. Housing starts
3
2
1
0
Source: USDC Bureau of the Census
D. Wood production and stumpage
Million board feet
6000
4000
2000
Private
Doug-fir stumpage PNW
400
200
0
1982 $ per MBF, Scribner rule
Lumber and wood products jobs in the Pacific Northwest
Jobs per million board feet of harvest
E. Jobs
Jobs per mmbf
12
8
4
0
160
120
80
40
0
Thousand of persons
1960
1970
1980
1990
2000
10 years under the Plan

Fig. 3-1
(color)

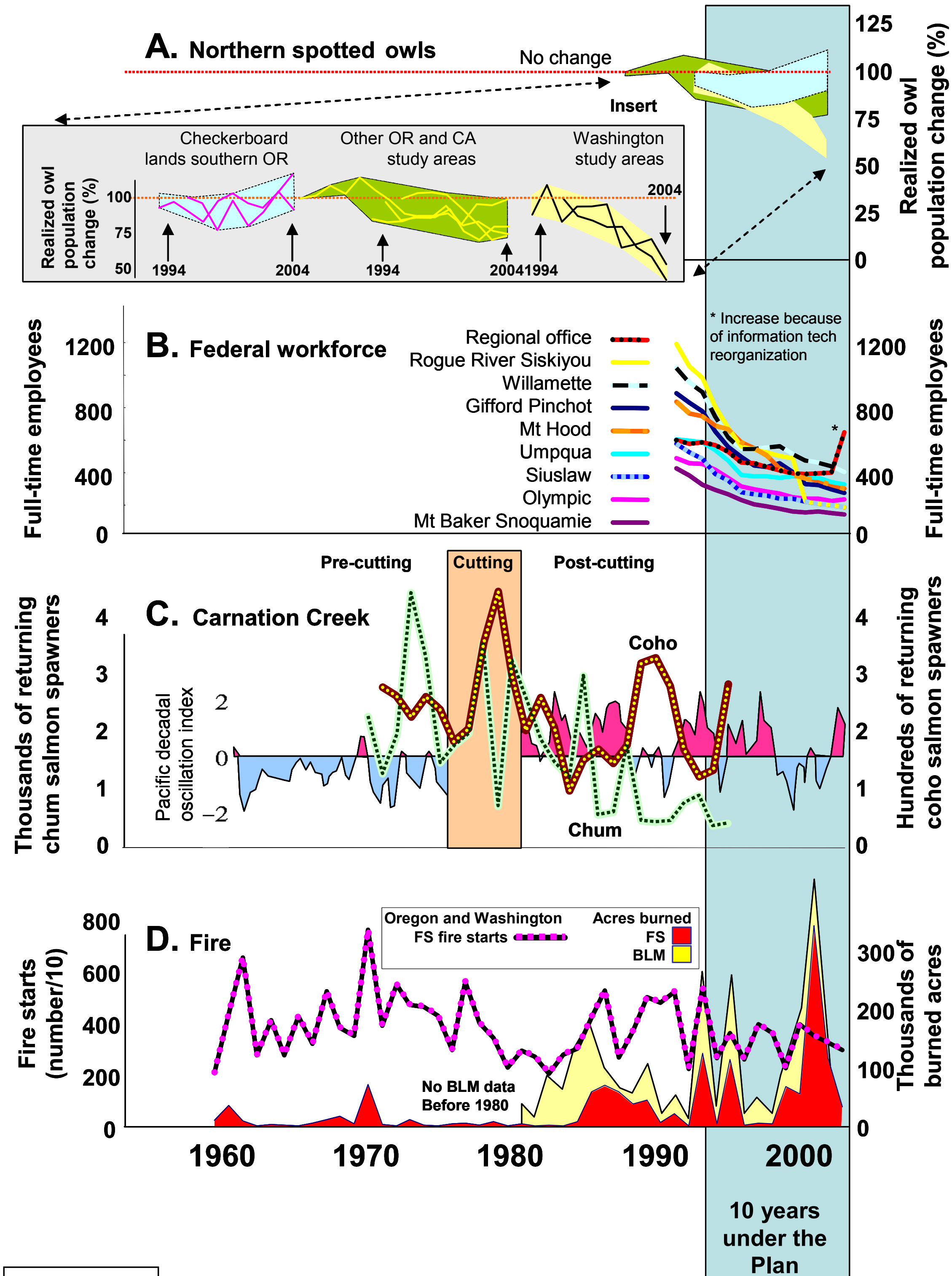

A. Northern spotted owls
No change
Insert
Realized owl population change (%)
125
100
75
50
25
0
Checkerboard lands southern OR
Other OR and CA study areas
Washington study areas
Realized owl population change (%)
100
75
50
1994
2004
1994
2004
1994
2004
B. Federal workforce
Full-time employees
1200
800
400
0
Regional office
Rogue River Siskiyou
Willamette
Gifford Pinchot
Mt Hood
Umpqua
Siuslaw
Olympic
Mt Baker Snoquamie
* Increase because of information tech reorganization
Pre-cutting
Cutting
Post-cutting
C. Carnation Creek
Thousands of returning chum salmon spawners
Hundreds of returning coho salmon spawners
Pacific decadal oscillation index
2
0
−2
Coho
Chum
D. Fire
Fire starts (number/10)
800
600
400
200
0
Oregon and Washington FS fire starts
Acres burned
FS
BLM
No BLM data Before 1980
Thousands of burned acres
300
200
100
1960
1970
1980
1990
2000
10 years under the Plan

Fig. 3-2
(color)

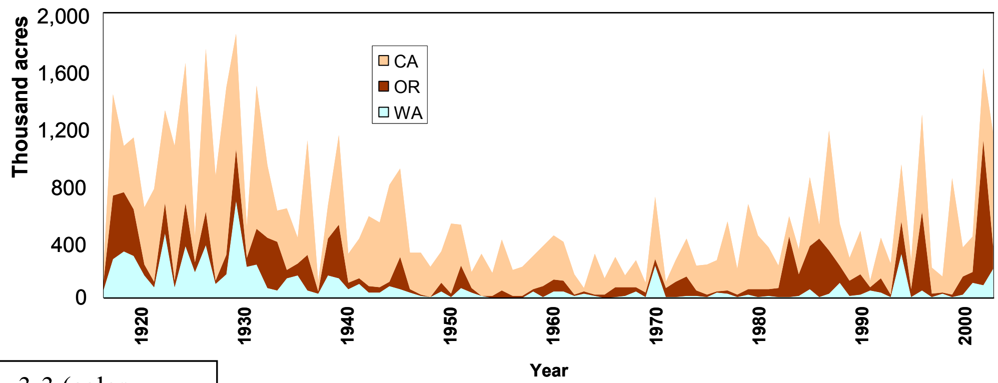
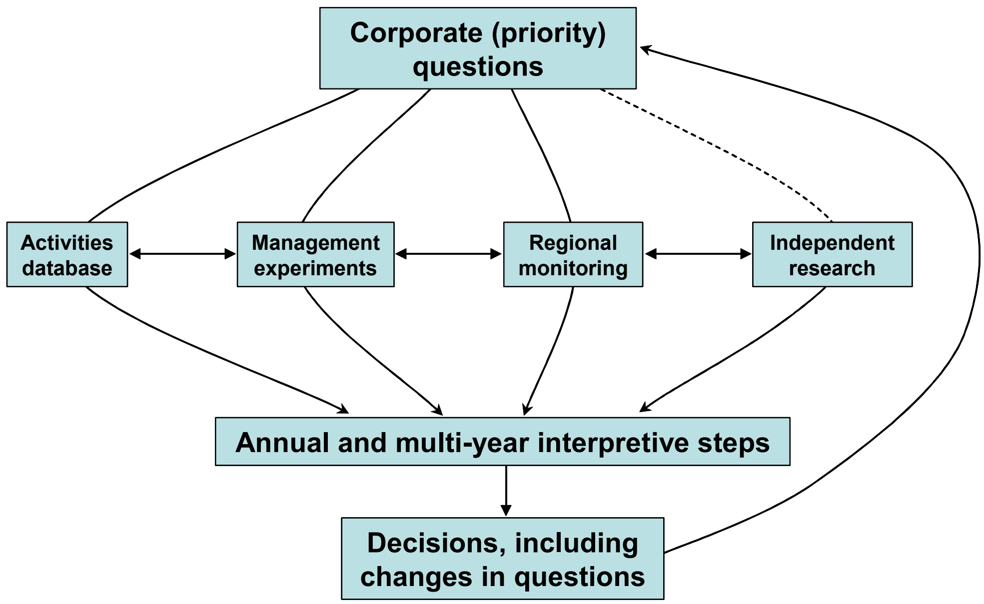


Fig. 3-3 (color needed)

Fig. 3-4 (no color needed)



Best Practice Versus Diversified Practice

Best practice and diversified practice in some ways are genuinely contradictory. A best practice is typically defined when researchers and managers agree on the effects various practices will have on the ecosystem, and can choose the single practice ranked best. This choice does not mean that the practice will prove to be the best—after all, taking logs out of streams was once a best practice, as putting them back is now. Diversified practice makes sense either when consensus cannot be reached or when scientists agree that the existing evidence is insufficient to distinguish between alternative hypotheses with confidence. Under these circumstances, ranking practices does not make sense, and in the spirit of not putting all of your eggs in one basket, managers can logically decide to take multiple approaches. When uncertainty is high, diversified practice follows from, and is consistent with, the well-known scientific method of multiple working hypotheses (Chamberlain 1897).

An example: How could forests and salmon habitat be managed to sustain salmon populations? Our understanding of the mechanisms by which forest stream habitat condition affect numbers of salmon is not well developed. We know watersheds vary in important ways and that many factors affect population numbers. We can certainly say that salmon spawning and rearing habitat is necessary, but not sufficient, for salmon populations. Beyond that, more quantitative relations have proved elusive. Is this a failure of the scientists to solve a research problem? No, the problem is simply too complex and too variable to admit easy answers. Does this mean that the appropriate philosophy of science here is the method of multiple working hypotheses? Probably so. These, then, are issues in the conduct of science that may also be relevant input for managers.

Chapter 4: Summary

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Introduction

The inferences and opinions expressed in this report attest to the complex nature of the Northwest Forest Plan (the Plan) and its far-reaching effects on the socioeconomic and ecological fabric of the Pacific Northwest. The major points raised can be summarized by addressing four interconnected questions:

- Has the Plan resulted in changes that are consistent with objectives identified by President Clinton?
- Are major assumptions behind the Plan still valid?
- Have we advanced learning through monitoring and adaptive management?
- Does the Plan provide robust direction for the future?

Measurable Progress

President Clinton challenged federal agencies to work together to develop a scientifically credible plan to protect the long-term ecological health of federally managed forests, while providing sustainable levels of forest products that would contribute to the economic stability of the region. Has the Plan resulted in changes that are consistent with the objectives identified by President Clinton? Ten years after it was initiated is too soon to judge whether it has been fully successful, but some trends are clear.

The most notable accomplishments are associated with protecting old-growth and riparian forests and associated species. Harvest of trees in old-growth and riparian areas has dwindled to insignificant amounts compared to historical harvest rates. The Plan protects most existing old-growth stands from future harvest, and other mid-seral stands are slowly developing old-growth characteristics, such as large trees and multistoried canopies. Other successes include active watershed restoration and decommissioning of roads, site-specific protection of sensitive species, improved watershed planning processes, increased understanding of the distribution and habitat needs of species of concern, and advancing silvicultural practices to accelerate old-growth development.

The Plan also fell short in some arenas, most notably in providing for a “predictable and sustainable level of timber sales and nontimber resources” and “new economic opportunities for year-round, high-wage, high-skill jobs” (FEMAT 1993, chapter 3). Specifically, timber harvest rates were lower than expected. Current overall harvest rates likely can be sustained, but only if the mix of harvest prescriptions change through time to match changes in the structural composition of forests. Timber shortfalls resulted in economic hardship for some communities, but others were able to compensate by increases in other economic sectors or through active civic leadership. Active fuels management in the drier forests of the eastern Cascades and Klamath-Siskiyou regions lagged behind expectations, perhaps increasing the risk of uncharacteristic large or severe fire in these regions. Large fires, such as the Megram fire in 1999 (125,000 acres) and the Biscuit fire in 2002 (500,000 acres), resulted in substantial losses of old-growth forests and local increases in watershed degradation, but disturbance rates averaged over the Plan area were consistent with expectations.

The Plan failed to fully end “the gridlock within the federal government,” although increases in cooperation among federal agencies and between research and management were noticeable. An understandable lack of consensus among stakeholders and the agencies contributes to continuing stalemate in some areas.

Validity of Assumptions

The Plan rested on many wide-ranging assumptions either explicitly identified in planning documents or implied through the Plan’s direction and expectations. Various lines of evidence support the veracity of many of these assumptions, yet others have been challenged by new findings or emerging knowledge. Testing and refining assumptions is a critical step towards improved understanding and ability to manage effectively.

Many Assumptions Remain Valid

One of the Plan's central assumptions was that old-growth forests (especially those with older forest structure) were limited in distribution and that the network of reserves identified in the Plan would encompass most of the remaining old growth. Updated (and more accurate) inventories are remarkably consistent with pre-Plan regional estimates of old-growth forest and reaffirm the assumed overlap of old growth and the reserve network (chapter 6). The network of late-successional reserves and Congressionally reserved areas was also assumed to include most of the best remaining habitat for northern spotted owls and other old-growth dependent species. Recent estimates identified 10.4 million acres of owl habitat in these areas, representing 57 percent of the owl habitat available on federal lands (Lint, in press, chapter 7). Owl habitat also was thought to be an adequate surrogate for marbled murrelet habitat where the two species overlap, and it was assumed that the Northwest Plan reserve strategy would include 86 percent of the federally controlled murrelet nesting habitat. Improved modeling of murrelet habitat has produced similar estimates (81 percent), suggesting that the original planners successfully identified much of the nesting habitat on federal lands. Whether protection of habitat has halted declines in owl or murrelet numbers is a complex, and yet unanswered question (chapter 7).

In a similar context, key watersheds that were assumed to be in better condition than most were identified as part of the aquatic conservation strategy. The aquatic monitoring effort demonstrated that key watersheds generally have fewer roads and higher rates of road decommissioning, which accounts for higher condition scores (Gallo and others, in press). The aquatic strategy was designed using a body of science that pointed to the dynamic interconnections of riparian vegetation, large wood, sediment, and landscape disturbance. Subsequent research has further strengthened the underlying assumptions of the ACS (chapter 9).

Monitoring results reinforce several other key assumptions of the Plan. For example, forest inventory data abundantly demonstrate that trees can grow quickly in the productive forests of the Pacific Northwest. Increases in mean tree diameter in undisturbed stands suggest that new old-growth forests are being naturally recruited, with positive implications for both terrestrial and aquatic species. It is still unknown how rapidly these new old growth forests will acquire the structure of older forests.

Experimental thinning in plantations demonstrated that some old-growth features, such as large trees and spatial heterogeneity, could develop more rapidly following treatment; other features, such as species diversity, may simply require time (chapter 6). The implications of accelerated development are not fully understood. Clearly, many species are associated with old-growth forests, but whether they respond solely to structure or to more time-dependent processes (dispersal, for example) is often unknown.

Two of the more controversial issues in the Plan include the permanency of reserve boundaries and salvage logging in reserves. The Plan assumed that reserve networks would be large enough to withstand large disturbances without loss of function. Thus far, that assumption seems to hold true. Whether fixed reserves are an optimal strategy for conserving biodiversity in the long term remains an untested assumption. Indeed, testing such a broad-scale, long-term hypothesis is not possible in a short time period. In chapter 6, we note that the direction for salvage logging in late-successional reserves was unclear, but left open the possibility of limited salvage logging for commercial purposes. An underlying assumption was that the rationale for salvage logging was primarily economic, not ecological, and little salvage in reserves would occur. Emerging science findings confirm assumptions about the ecological functions of downed wood and large snags following wildfire. Retention of large, dead tress following stand-replacing wildfire provides long-term benefits consistent with the ecological goals of the Plan.

Unsupported Assumptions

Several assumptions incorporated into the Plan have since shown to be unsupported, or only weakly supported, by new evidence or understanding. Assumptions were challenged regarding both socioeconomic and ecological relations, with implications for both. One of the more important set of findings concerns the role of the federally managed lands. From a socioeconomic perspective, it was assumed that timber flows from federal lands was a key determinant of community well-being. As discussed in chapter 5, this is true in some communities, but not in most. Looking more broadly, the presumption that federal lands would continue to be a major supplier of high-grade commercial timber is questionable. The dominant social values expressed in forest management may have changed since Plan inception. For example, law suits, threats of law suits, and protest regarding harvest of old-growth forests in matrix areas or thinning older forests in reserves has resulted in lower-than-anticipated harvest levels, and have slowed the pace of active management. The results include unanticipated amounts of old growth remaining in matrix areas and elevated risk of uncharacteristic severe fire in dry forests, with positive and negative implications for species of concern. Post-Plan information on species' distributions and habitat preferences can aid local or regional assessments of whether old-growth harvest in matrix areas or additional fuels treatments in dry forests threaten species viability.

Experience with the Plan has led to important changes in how ecosystem processes are viewed and the applicability of various conservation paradigms. For example, the northern spotted owl was used as an umbrella species; it was assumed that conserving the habitat of spotted owls would provide for the needs of many other old-growth dependent species. Because of the survey and manage program, we now recognize that a single-species focus may not be effective for all old-growth related species, and that more holistic strategies may be required. The identification of barred owls and West Nile virus as potential threats to northern spotted owls demonstrates that providing habitat is a necessary but not sufficient condition for conserving species. That disturbance is an important component of ecosystem productivity and biological diversity is increasingly recognized; positive long-term benefits can arise from episodic disturbances at a variety of spatial and temporal scales.

Advances in Learning

Many of the issues involved in monitoring and adaptive management discussed in Chapter 10 are briefly summarized here by asking, “have monitoring and adaptive management advanced learning?” Overall, the answer is a qualified yes. Some notable successes were achieved, but also some failures; improvements are possible in places.

Without question, the monitoring program produced a wealth of data and information. Major improvements in remote sensing and forest inventories provide a detailed picture of current forest conditions throughout the Plan area and allow tracking of changes in these forests. Species surveys and population monitoring aid understanding of the distribution and habitat needs of many species and provide indicators of change for select species. Because of the survey and manage program, for example, more than 67,000 species locations were mapped—an unparalleled achievement for a monitoring program over a similar-sized area. The northern spotted owl monitoring program is one of the most intensive avian population monitoring efforts in North America. The aquatic and riparian monitoring effort is systematically building a database on riparian and instream conditions that is amenable to both monitoring and exploring linkages among ecological drivers and responses at multiple spatial scales. Despite its late start, the socioeconomic program has produced findings that aid understanding of the large-scale context of the Plan, as well as its regional and local impacts.

Room for improvement can be found, however, even in the most successful programs. Some efforts are still in nascent phases; judging their ultimate success is difficult. Funding shortfalls and disagreements on design slowed implementation of the aquatic and riparian monitoring program. The marbled murrelet monitoring effort also took time to get underway, which limits the time series available for analysis. A general plan for monitoring biodiversity was not developed; even defining biodiversity pragmatically is difficult (chapter 8). Inconsistencies between agencies and administrative units continue to impede integration of data in multiple ways. For example, differences in remote sensing and classification methods created problems in developing a seamless vegetation map stretching from California to Oregon and Washington.

Experimental management has produced useful, but spotty results. Much of the success has come from stand-level experiments such as variable-density thinning in plantations or combinations of prescribed fire and thinning in experimental forests. Rigorous broad-scale experiments were lacking. Experience with adaptive management areas is generally disappointing, because they have not facilitated the degree of innovation and experimentation expected. Too often, precaution seems to have trumped learning. As discussed in chapter 10, carefully focused questions, quantifiable expectations, efficient monitoring, and well-structured comparisons could accelerate learning.

Looking to the Future

Invariably, the question arises as to whether observations of the past decade provide evidence that the Plan is or is not working and warrants revision. Science alone cannot offer a definitive answer to this question, nor should it. To assert that the Plan is working requires subjective judgments for which no consensus exists. The Plan is too complex and diverse to give it a simple pass-fail grade. Clearly, some expectations of the Plan have been met more successfully than others, but it is too early or too difficult to judge most outcomes. How the Plan is ultimately judged depends on expectations, the value assigned to its various components and consequences, and beliefs about the possible performance of alternative strategies. Judging the Plan is much like trying to evaluate the performance of a sports team early in the season, when team cohesion is weak and their strengths and weaknesses have not been fully tested nor revealed, and observers have their own criteria for declaring success.

Various observations on the Plan and its ability to help federal agencies address major management challenges are reviewed below. These observations are organized by the types of problems that characterize particular issues, rather than by topical areas. The various issues and their similarities are assessed in terms of appropriate scale, temporal tradeoffs, or interactions between pattern and process. Finally, the Plan's flexibility to address a range of issues is examined.

Appropriate Scale

The importance of spatial scale is an oft-repeated theme in this report. That is, every major issue has its own characteristic scale or mix of scales. Mismatches between the scale of a management response and the characteristic scale of the issue can contribute to ineffective management. For example, the Plan is addressed exclusively at federally managed lands. For socioeconomic issues, federal lands are a small part of local, regional, and even international economies. Thus, trying to anticipate or assess the Plan's effects without looking at the larger context is illogical. On the ecological side, wide-ranging species like anadromous salmon and marbled murrelets cannot be managed effectively on federal lands alone. Other issues like invasive species and wildland fire do not recognize administrative boundaries. The federally managed lands are vital to solving wide-ranging problems, but overall societal goals cannot be met by partial fixes. Therefore, integrating the Plan with trans-boundary planning efforts such as the National Fire Plan, the Northwest Power Planning Council's fish and wildlife program, or other state and federal efforts can help build partnerships essential for success.

Below the level of trans-boundary problems, other spatial-scale issues fall wholly within the federal estate. Chapter 6 touches on the linkages between size and distribution of reserves and the purposes they are intended to serve. Limited historical evidence suggests that they are large enough to be resilient to certain types of disturbance, but hardly impervious. Chapters 8 and 9 discuss the role of complementary coarse- and fine-scale filters in species conservation. The lesson is that some species may fall through the cracks of a coarse-scale policy that expects large reserves to meet the needs of all species. Some level of fine-scale protection of unique habitats or even of individuals (for example, nesting pairs of owls) may be required. Chapter 9 also discusses the importance of managing within watersheds by looking across a range of stream sizes and upstream-downstream and upslope-riparian perspectives, and discusses that broad-scale strategy of managing for a range of watershed conditions. Chapter 3 identifies the lack of mid-scale planning to help match the Plan's strategic direction to an appropriate scale of action.

Temporal Tradeoffs

The questions of appropriate spatial scale are paralleled by issues of temporal scale. One pervasive issue is that of the tradeoffs between short- and long-term consequences. This issue is particularly acute when a short-term impact (or benefit) is highly probable but small, relative to a less likely but more substantial long-term benefit (or impact). The classic example is fuels management in fire-prone ecosystems; the negative short-term effects on sensitive species such as spotted owls can be balanced against possible long-term benefits of reduced losses in habitat to high-severity fire. A second example is salvage logging. Salvage logging may provide short-term economic gain and reduce fuel loads (depending on methods), but also may have long-term consequences for soil compaction, erosion, or loss of unique early successional habitats containing large downed wood and snags (chapter 6). Indeed, the more general question of active management versus passive protection invariably invokes temporal comparisons. As discussed in chapter 10, simple rules such as the precautionary principle do not assure an optimal solution.

Moreover, temporal tradeoffs are implicit in decisions about agency organization, staffing, training, and investment in research or learning. Just as physical infrastructure constrains management options, the same is true of social capital, agency technical capacity, knowledge, and technology. Major reductions in agency workforce affect the ability to plan and implement projects. Federal workforce reductions also affect rural communities, where federal workers may be some of the more highly educated and influential residents (chapter 5). The discussion in chapters 3 and 10 regarding agency capacity for adaptive management and mid-scale planning reinforce a basic truth—you cannot build a trustworthy ship without shipwrights.

Science played a major role in shaping the Plan and scientists continued to be active in implementing, monitoring, and assessing its effects. A shift towards advanced technologies (for example, internet, GIS, and remote sensing) has improved efficiency, changed agency operations, and even revamped how federal agencies engage and interact with the public. Management challenges continue to grow and become more complex, however, making prudent investments in research and learning even more critical. Such investments reflect additional tradeoffs between short- and long-term gains. Funds invested in monitoring and research are not available for other uses nor can the benefits be guaranteed. In these cases, we need to be sensitive to the information needs of management (and society in general), and identify explicitly the expected benefits and risks of investments in research and monitoring.

Pattern and Process

A third—and perhaps most daunting—set of problems in ecosystem management involve interactions between pattern and process. Similar to the issues of appropriate scale, pattern and process are intertwined concepts for describing, understanding, and managing landscapes—with a temporal twist. Pattern, the spatial arrangement of landscape components, is a consequence of process, the interactions between ecological components acting on a landscape. Just as pattern results from processes, processes are also constrained by pattern, but more than just pattern; other ecological components can be involved. An example is wildland fire. Fire acts in concert with other processes to shape spatial patterns of vegetation structure. Conversely, the expression of fire on a landscape is constrained by vegetational patterns and topography. The challenge is that these processes are often not directly observable and they are inferred from landscape patterns. Managers face a more difficult challenge in that they use processes to shape pattern, hoping that the patterns they create will affect other processes outside of their direct control. For example, agencies use prescribed fire and thinning to create fuel breaks intended to alter wildland fire behavior, such that areas of concern do not burn or else burn at low intensity.

Several of the more challenging topics addressed in this report involve interactions of pattern and process. One example is the relation between forest development (succession) and disturbance. Understanding of how individual trees, stands, and even complex landscapes develop in ways that either retard or encourages certain types of disturbance is evolving. The variety and distribution of old-growth characteristics described in chapter 6 are derived in part by such interactions at multiple scales. Another example is the interaction of terrestrial disturbances and stream-channel dynamics discussed in chapter 9. Invasive species and disease are additional issues that invariably include interacting processes affected by pattern.

The challenges of understanding and managing spatial pattern and processes come to the fore throughout the Plan, but nowhere more critically than in designating land allocations. The Plan may represent new thinking in resource management, but its primary mechanism is one of the oldest tricks in the book—multiple-use management by dominant-use zoning. Because of the Plan, the federal estate can be viewed as a collage of overlapping land-use designations, with each designation bringing its own set of standards and guides, and a second set describing which directions take priority. Thus a single landscape can have late-successional reserves, key watersheds, riparian reserves, Congressionally reserved lands, adaptive management areas, and sundry other special use designations. These comprise only the administrative boundaries. The real landscape has its own tapestry of natural features (topography, soil, rainfall, stream networks, vegetation, fauna, and such) intersecting with human elements (like roads, farms, homes, cities, and dams). The administrative designations are expected to dictate human activities that will work with natural processes and existing features to create a desirable landscape pattern of ecological attributes. Presumably, this pattern will constrain natural processes so the desired landscape is sustained for people to enjoy. The old saw, “it isn’t rocket science,” certainly applies; rocket science is not this hard!

The issue of land allocation segues naturally into conflicts between active and passive management. Many of the land designations are primarily proscriptive; that is, they prohibit activities rather than call for action. As such, they reflect the precautionary principle implemented as a restriction on activities that might have negative effects (chapter 10). To some extent, they also reflect what Hargrove (1994) calls “environmental therapeutic nihilism,” a belief that nature is too complex to manage intelligently and thus should be left alone to heal whatever ails it. Other tenets of this philosophy are reflected in the Plan and our assessment of its effectiveness. For example, the discussions of the benefits of natural disturbance in chapters 6 and 9 echo a parallel adage in human health that “whatever doesn’t kill you makes you stronger.” Although the premises that natural disturbances can be positive and ecosystems have natural recuperative powers have evidentiary support, experience with the Plan also illustrates the limits of such truisms. Every problem does not require active intervention, but some do.

Flexibility Provided by the Plan

The region affected by the Plan is an area of both remarkable similarities and pronounced differences. Traveling north to south or west to east reveals remarkable gradients in climate and topography, with resultant ecological variations in forest types and associated species. Equally remarkable are the socioeconomic differences between large metropolitan areas like Seattle, Washington and Portland, Oregon and the resource-dependent rural communities scattered throughout. For someone unfamiliar with the Plan’s genesis and its tie to the northern spotted owl, it would seem an odd collection of lands to be grouped under one management plan.

Accommodating the intraregional ecological and socioeconomic diversity has been a major challenge to those designing and implementing the Plan. Opinions differ whether the Plan intended for considerable discretion to adapt standards and guides to provincial or site-specific differences, but a reluctance or resistance to change default standards and guides is apparent. Flexibility and willingness to use it are essential to matching management actions to local conditions and improving efficiency. Exercising discretion is a standard approach to managing risk. For example, the quickest and safest way to travel between two points is to match your speed to the road conditions, not to drive at a constant speed. Flexibility also can allow for increased experimentation, and hence enhance opportunities for learning, leading to more efficient and effective ways to meet plan objectives.

The Plan represents an ambitious, long-term vision for managing federal lands of the Pacific Northwest, but it remains to be seen how well it can endure. Carrying the vision forward promises to be a continuing challenge; this requires building on the successes of the Plan and improving its shortcomings. Changes in social expectations and values, administrative policies and procedures, and sundry other socioeconomic factors will play out in unforeseen ways. Equally important are the inevitable ecological surprises, such as large-scale disturbances, invasive species, droughts and disease, and climate change that will strain ecosystem resiliency and potentially lead to major shifts in forest communities. In an era of declining federal funding and personnel, management agencies will be further challenged to improve partnerships and collaboration to leverage limited resources to meet growing societal demands. The only prediction that can be made with certainty is that information, knowledge, and creativity will always be essential ingredients for success.

Chapter 5: The Socioeconomic Implications of the Northwest Forest Plan

Richard W. Haynes and Elisabeth Grinspoon

Introduction

Socioeconomic issues are at the root of the controversy that led to the development of the Plan and to the social and economic monitoring questions. This controversy emerged in the late 1950s and revolved around three related issues: the role and amount of federal timber in timber markets; the federal agencies obligations' to maintain communities near or among federal timberlands; and the role forests play, especially federal forests, in regional economies.

These issues were first identified in the mid 1950s as employment declined in the Pacific Northwest forest products industry while harvests remained relatively stable (Smith and Gedney 1965). These trends are shown in figure 5-1a. Jobs per million board feet of harvest declined progressively from 1950 to 1975 (see fig. 5-1b), as the industry modernized mills, shifted from using mostly private timber to using a mix of public and private timber, and diversified to include high-value log export and plywood industries. During the mid 1980s, trends in jobs per million board feet reversed and began increasing to levels higher than in the early 1950s. The reversal in trends was due to changes in the mix of products and increases in production of logs that were formerly exported for processing overseas.

By the 1990s shifting societal environmental values were changing the objectives for federal forest management[1] to favor increased old growth and habitat protection over timber management on federal forest lands.[2] This shift was manifest in the Dwyer ruling, the forest conference, and the development of the Plan (see chapter 1 for more details). The Plan was adopted with the expectations that it would settle conflicts over federal forests and lead to a new era in resource management.

One other notable aspect to this evolving debate was that social questions became included in public debates about forest policy. As Clark and others (1999) observed the 1993 Forest Conference, held in Portland, Oregon, that led to the development of the Plan marked the first time that social scientists were invited to participate in national forest policy debates. The Plan reflects the inclusion of social scientists and citizens in its formation since it was guided by the principles spelled out by President Clinton who reminded us that forest management is a social problem, embodying questions of how society chooses among possible futures.

Employment has been a key issue in forest policy discussions since the late 1960s. The issue arose in the mid 1950s when employment declined in the forest products industry while harvests were relatively stable (Smith and Gedney 1965). Further employment declines in the late 1950s and early1960s raised policy questions about how to manage employment instability in a sector that was a major source of income and employment in Washington, Oregon and California. The ensuing policy discussions set the context for many policy debates that shaped FEMAT (1993) and the Plan (as implemented by the ROD, USDA and USDI 1994b). In 1975, Wall and Oswald summarized these policy discussions as:

- Employment instability can cause severe hardships on individuals and families and economic distress in local and regional economies.
- High rates of timber harvest and product output from Washington, Oregon, and California that have been sustained by harvest of old-growth cannot be sustained in the future.
- Diminished timber availability will result as more alternative uses of forestland are considered.
- Prospects for tightened timber supplies from Washington, Oregon, and California reduce the competitiveness of locally produced wood products in national and international markets, with potential regional economic and community effects.

Assessment of Social and Economic Trends Associated with the Plan

The Five Socioeconomic Monitoring Questions

At the Forest Conference President Clinton enumerated five principles to guide the development of the Plan. These principles emphasize social and economic components, including new economic opportunities for year-round, high-wage, high-skilled jobs;

protecting the forests for future generations; legal responsibility; predictable and sustainable levels of timber sales; and, collaboration among federal agencies for the public good (FEMAT 1993, ii).

To measure progress toward implementing the Plan, the ROD (USDA and USDI 1994b) included a monitoring and evaluation plan. Three of the questions it poses focus on socioeconomic issues. The first relates to rates of using natural resources: Are predictable levels of timber[3] and non-timber resources available and being produced? The ROD specifies seven key items to monitor to answer this question: timber harvest rates, special forest products (like mushrooms, boughs, and ferns), livestock grazing, mineral extraction, recreation, scenic quality (including air quality), and commercial fishing.

The second question relates to rural economies and communities: Are local communities and economies experiencing positive or negative changes that may be associated with federal forest management? The ROD (USDA and USDI 1994b) specified eight key items to monitor under this question including demographics, employment (timber, recreation, forest products, fishing, mining, and grazing), government revenues (USDA Forest Service (FS) and USDI Bureau of Land Management (BLM) receipts), facilities and infrastructure, social service burden (welfare, poverty, aid to dependent children, and food stamps), federal assistance programs, (loans and grants to states, counties, and communities), business trends (cycles, interest rates, and business openings and closings), and taxes (property, sales, and business).

The third is a set of questions related to American Indians and their culture: For those trust resources identified in treaties with American Indians, what are their conditions and trends? Are sites of religious and cultural heritage adequately protected? Do American Indians have access to and use of forest species, resources, and places important for cultural, subsistence, or economic reasons, particularly those identified in treaties? Key monitoring items include: conditions and trends of the American Indian trust resources, effectiveness of the coordination or liaison to assure protection of religious or cultural heritage sites, adequacy of access to resources and to the vicinity of religious or cultural sites.

The ROD (USDA and USDI 1994b) did not explicitly identify social and economic goals and objectives for Plan but they are described in other Plan-related documents (Pipkin 1998, Tuchman and others 1996). The monitoring team identified five socio-economic objectives that could be used to measure progress toward the goals of the Plan.

The objectives are:

1. To produce a predictable and sustainable supply of timber sales, nontimber forest resources, and recreation opportunities that would help to meet the second objective;
2. To maintain the stability of local and regional economies on a predictable and long-term basis;
3. To minimize adverse effects on jobs by assisting with economic development and diversification opportunities in those rural communities most affected by the cutbacks in federal timber sales;

4. To establish a system of terrestrial and aquatic reserves that would protect forest values and environmental qualities associated with late-successional, old-growth, and aquatic ecosystems; and

5. A new approach to federal forest management in which federal agencies would collaborate and coordinate with one another.

Evaluating How Well the Plan Preformed

In this section we provide a concise discussion of how well federal agencies did in meeting Plan objectives with review of trends in key variables. Information from the Socioeconomic Status and Trends Report (Charnley and others, in press a: exec summary) suggests that federal agencies made limited progress in meeting the Plan's socioeconomic objectives. The BLM was more successful than the Forest Service in providing a stable flow of socioeconomic benefits to communities in the Plan area because the budgets of the BLM field units rose over the past ten years, while those of the Forest Service fell. Thus the BLM had resources to invest in new ecosystem management activities that were aligned with Plan goals such as recreation and restoration that provided local communities with some socioeconomic benefits. The Forest Service field units, on the other hand, encountered problems in maintaining basic management activities. What was expected from each objective and what actually happened in implementing the Plan is summarized in table 5-1. It also shows the differences between the two.

Produce a predictable supply—

The general expectation was that the Plan would produce a reduced, yet predictable supply of timber from the national forests in the range of the northern spotted owl. In 1994, the Northwest Forest Plan Final Supplemental Environmental Impact Statement (USDA and USDI 1994a) estimated an average annual probable sale quantity (PSQ[4]) of 958 million board feet of timber annually. The Forest Service reduced the PSQ several times after 1994. Despite the reduced PSQ, the average annual volume of federal timber produced in the Plan area during the first decade of plan implementation (1994-2004) averaged 34 percent of the expected annual PSQ for the decade. From data collected for the Socioeconomic Status and Trends Report this difference was attributed to the time required for agencies to complete the surveys and assessments required by the Plan as well as to prepare sales consistent with the standards and guides (USDA and USDI 1994b).

The relations among timber offered, sold, and cut as well as the uncut volume under contract for the "Owl Forests"[5] in Pacific Southwest Region (R5) and Pacific Northwest Region (R6) are shown in figures 5-2a and 5-2b. During the 1990s, national forests harvests (also called cut) fell 96 percent in Region 6 and 90 percent in Region 5. These declines followed similar reductions in timber offered for sale. To complicate the decline in timber volumes, the quality of timber sold also declined. Evidence of this decline is the change in the relation in stumpage prices for timber sold by various public agencies. Until the early 1990s, the Forest Service sold a mix of logs for the domestic market. The price averaged 83 percent of the log mix sold by Oregon and Washington state agencies.

Recent sales not only are a fraction of former ones but also are of lower quality, as shown by stumpage prices that average 56 percent of those of the two state agencies.[6]

The timing of the effects associated with federal harvest reductions were mitigated somewhat by the uncut volume under contract (see figs. 5-2a and 5-2b). This uncut volume, small increases in private timber harvest, and a decline in log exports all mitigated the effects of the reduction in federal harvest. The nontimber forest products industry also experienced reductions in the export markets because of downward changes starting in 1997 in Asian economies that have generally reduced prices for some products. In addition the labor forces used to gather floral greens have changed significantly (see Lynch and McLain 2003) further reducing local employment opportunities.

Maintain community stability–

Much of the debate about the details of the Plan were based on the assumption that reductions in federal timber flows would reduce local employment opportunities, thereby negatively affecting socioeconomic well-being and threatening community stability. The impacts were mixed as some communities adjacent to federal forest land experienced decreases in socioeconomic well-being while others found ways to adapt to declines in timber production and other changes in social and economic conditions.[7]

The problems of communities near forest service land were exacerbated by the direct loss of forest service jobs. Many Forest Service employees were active community members serving in various roles. The loss of employment opportunities (either direct employment in the forest products industry or working for the Forest Service) negatively affected the capacity of communities to cope with the social and economic transitions associated with the Plan. In some areas where timber jobs were lost, the departure of timber workers caused families to break apart across generational lines when younger workers had to leave their homes to find work in other areas. Summaries of the interviews conducted as part of the Socioeconomic Status and Trends reports (Charnley and others, in press b) reveal that after a decade; grief, anxiety, frustration, and anger accompanied this change.

Although community well-being has changed at the regional-scale, it did not change as Plan opponents claimed it would. In the Plan area 36 percent of communities enjoyed increases in well-being and 37 percent experienced decreases (see Charnley and others, in press b, for details). The rest of the communities remained constant. At the regional scale, some of the potentially negative economic changes associated with the Plan were obscured by rapid growth in population. Total population grew at a rate faster than did the rest of the United States. Increases in educational attainment and household income are also increasing as poverty is decreasing. These positive changes may be related to the attractive natural landscapes that draw new people seeking the natural amenities to the Pacific Northwest.

Some of the community impacts were mitigated by the Secure Rural School and Community Self-Determination Act (2000) (P.L. 106) which provides payments to counties that historically shared revenues from goods and services sold from Forest

Service land. The Secure Rural Schools Act replaced past dependence on timber-harvest revenues and has generally mitigated the lost revenues associated with the declines in federal timber harvest in the region (see Phillips, in press).

Assist with economic development–

A key component of the implemented Plan was an explicit attempt to mitigate the social and economic consequences of reduced federal timber flows. Much of this effort was through the Economic Adjustment Initiative, the Initiative which focused the agencies on considering their role in the long-term economic development and diversification in the Plan region. Christensen and others (1999), Kusel (2002), and Tuchman and others (1996) describe the successes and shortcomings of the Initiative. For some communities, the Initiative provided economic assistance that went far beyond face value of the dollars it provided. Some communities were able to use Rural Community Assistance grants to leverage money from other sources. The way that the Initiative was administered also facilitated new collaborative relations to form between the agency and communities.

Efforts to diversify the economies of the Pacific Northwest were largely implemented through various state programs, but outcomes have been difficult to determine given the economic growth and diversification of the United States and regional economies. A decade later, strategies for economic development have evolved that challenge the earlier approaches of attempting to replace manufacturing jobs with other manufacturing jobs. Economic development strategies now consider growing all sectors of functional economies.

Protect forest values—

The Plan was a product of the changing scientific and legal basis for managing forests for habitat conservation goals but it may not have adequately considered the increasing interest in forest protection among the American public. These changing societal values such as those revealed in the evolving definitions of old growth, as well as its use in increasingly more generic form, contributes to increased gridlock on federal timberlands. Recent surveys indicate the American public generally favors increased protection of Federal lands more than federal land managers, who are responsible for the management of these lands (Kennedy and others 2005, Shields and others 2002, Taylor 2002).

Surveys show that these values are relatively the same for both urban and rural residents with the exception of differences in who controls decisions. Rural residents want to be able to control decisions in their own area where urban residents are more willing to rely on more central decision making and control. The monitoring results reveal this first difference where a majority of the interviewees expressed concern over their loss of influence in decision making in activities that impact their local situation.

Promote collaboration–

In general enhanced collaboration among federal agencies was demonstrated by the Regional Ecosystem Office (REO) and other overarching institutions created by the Plan. Although inter-agency collaboration has improved, multi-scaled planning has been slower to evolve. Most planning energy was expended by local land managers struggling to situate their management activities in the Plan's context as a whole. The next generation of Forest Service and BLM unit planning are getting underway offering opportunities to strengthern mid scale planning activities that can help explain the location and timing of specific management practices.

Collaboration between federal agencies and local communities initially showed promise. Their potential for success, however, was diminished when federal officials were required to withdraw temporarily because of the adjudication and the chartering process associated with the 1972 Federal Advisory Committee Act. Even though the withdrawal of federal participants was temporary, trust in collaborative processes seems to have been damaged.

Some evidence was shown towards increasingly positive and more frequent collaboration between American Indian and federal land managers. Also provincial advisory committees have advanced interagency collaboration and coordination providing a forum for on-going multi-party discussions of forest management issues. These and other types of discussions seem not to have met expectations for engaging the public in new forms of collaboration that deliver benefits to communities. Mixed results from collaboration put at risk increases in public trust of land managers.

Tribal

Relations between tribes and federal land management agencies improved as a result of the Plan. The ROD (USDA and USDI 1994b) provides "a higher level of protection for

American Indian trust resources on public lands than the forest plans that it amends, and does not impair or restrict the treaties or rights of the tribes." These higher rates of protection are consistent with efforts in the 1990s to build effective processes for government-to-government relations with American Indian tribal governments.[8] They also underlie the three monitoring questions addressed in the Pilot study undertaken in 2000. The questions were:

1) How well and to what degree is government-to-government consultation being conducted under the Plan?
2) Have the goals and objectives of the consultation been achieved?
3) Is the consultation occurring because of effects on resources of tribal interest on federal lands or trust resources on tribal lands?

Both the Pilot study and various interviews included in the socioeconomic monitoring efforts reveal that while there are numerous definitions of "consultation" and significant differences of opinion as to what constitutes "effective consultation" there have been improved relations among tribes and federal agencies. The interviews also revealed that in some of the case study communities the tribes played a significant role in economic development as they built tribal government infrastructure or attempted to diversity economic opportunities for tribal members.

On the Olympic National Forest, for example, collaboration between the Quinault Indian Nation and the forest has been high during the last decade. The Plan's stress on the importance of watershed assessments has prompted interaction and collaboration. A recent land transfer and sharing of revenues generated from another parcel of land also produced legal and administrative ties between the agency and the Quinault Indian Nation that are fueling collaborative efforts.

Tribal communities, like other communities, had members who worked in the timber industry as loggers and mill workers and who lost their jobs in the early 1980s, when the regional timber industry began to decline. Interviewed community members believed that the Plan did not cause the decline in the local timber industry, but exacerbated already deteriorating conditions. The flow of socioeconomic benefits to some tribal communities around federal lands declined between 1990 and 2002, however, and strategies to mitigate the losses did not provide substantial benefits.

Are Plan Assumptions and Approaches Still Valid?

Sustainability

One of the key assumptions underlying the Plan was that it would promote sustainable resource flows and conditions. The basis for our understanding of sustainability, however, has changed over the last decade. On public lands we progressed from forest regulation based on sustained yield forestry to the adoption of ecosystem management approaches which seek balance among both biophysical and socioeconomic goals (see Haynes and others 1996, USDA FS 2005). At broad scale for all forestlands, we saw greater interest in understanding how individual actions contribute to progress towards achieving sustainable forest management.[9] For private forest lands and especially those owned by forest industry we have seen the integration of sustainability into their management systems using certification programs (such as the Sustainable Forestry Initiative and the Forest Stewardship Council, see Johnson and Walck 2004).

In today's context, elements of the Plan are consistent with components of approaches to sustainable forest management. One aspect has been the emphasis in the Plan on using a range of different forums for collaboration. Another aspect has been the consideration of using federal lands to achieve habitat conservation goals and to reduce regulatory risks for private lands owners. Selecting among the array of social, economic, and institutional indicators in the Montréal Process would be one approach for monitoring how well the Plan met its goals as well as progress toward sustainability.

The Montréal Process includes seven criteria. Of these, two focus on social and economic issues. Criterion 6 addresses the maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies. Criterion 7 speaks to the legal, institutional and economic framework for conservation and sustainable management. Within these two criteria are many indicators applicable to measuring how well the Plan met its goals as well as progress toward sustainability.

In terms of Criterion 6, the Plan was successful in maintaining and enhancing some of long-term socio-economic benefits. Specifically, the Plan did not meet its goals for production. Recreation opportunities, on the other hand, remained relatively constant. Investment in the forest sector declined sharply. Direct employment in the forest sector also declined. Many communities were viable and adaptable to changing economic conditions, while others were not. In some cases the Plan helped Federal Agencies meet cultural, social and spiritual needs.

With respect to Criterion 7, the legal framework (laws, regulations, and guidelines) of the Federal Government and the Forest Service supported the sustainability goals of the Plan for the most part. On occasion, however, the sustainability goals were hindered by the Plan. For example, the production of a predictable supply of timber, was hindered by complicated and overlapping laws and regulations. The Plan institutionalized a framework that supported and enhanced forest and cross-sectoral planning. Finally, the Plan did establish a monitoring program to help measure progress towards achieving broad scale land management goals.

While the Plan was considered sustainable when developed in 1994, it would not be judged that way today because today's definition of sustainability includes a focus on increasing economic prosperity and promoting social justice.[10]

Community Dependency and Adaptability

The Plan's socioeconomic goals assumed that there was a "need for a sustainable supply of timber and other forest products that will help maintain the stability of local and regional economies" (USDA and USDI 1994b). These goals were quickly extended to include the stability of communities--especially rural communities--in the northern spotted owl region.

During the 1980s, the debates surrounding community stability broadened to include discussion of how communities change and the "social contract" between land management agencies and communities. The scientists and interested publics endeavored to assess the extent to which the federal government is obligated by "legal" authority to recognize the standing of members of local communities. Their findings, however, suggested that they could make stronger arguments for the "moral" authority. These arguments were derived from the repeated commitments made to local communities in forest plans and the long-standing policies recognizing the rights of those who depend on federal forest land for their livelihood. These past commitments were embodied in forest-level plans developed in the 1980s.

In the past two decades, however, the terms used to depict communities with distinct connections to forest resources have evolved: community stability, forest dependence, forest-based, community capacity, community resiliency, and now with the Montréal Process, community viability and adaptability. This evolution of terms shows the evolving emphasis on the complex, dynamic, and interrelated aspects of rural communities and the natural resources that surround them. The earliest terms dealt with the limits between improved forest management and stable communities achieved through stable employment. By the late 1980s, concern was raised about the lack of a clear definition of stability and how it might be measured (see Richardson 1996) but the term stability continued to endure in policy debates. A number of efforts have sought alternative terms (see Donoghue and Haynes 2002 for a brief summary) and much interest has currently been focused around concepts like resiliency, capacity, and adaptability.

These new concepts emphasize the ability of a community (defined by a sense of place, organization, or structure) to take advantage of opportunities and deal with change (Doak and Kusel 1996, Harris and others 2000). They are dynamic, just like external factors that might induce change in a community. The evolution of terms suggests that connectivity to broad regional economies, community cohesiveness and place attachment, and civic leadership are greater factors in determining community viability and adaptability than are factors related to employment.

Concurrent with discussions about stability and well-being have been discussions about the term forest dependence. Dependence was initially defined by employment in forest product production but various research studies suggest that communities are more complex than traditional measurements would imply (see Haynes and others 1996). Most communities have mixed economies, and their vitality is often linked to factors other than commodity production. Many of the communities thought of as timber dependent have been confronted with economically significant challenges, such as mill closures, and they have displayed resilient behavior dealing with change. Arguments for redefining forest dependence emphasized that the economic ties that some communities have to forests are not wood product-based, but in recreation and other amenities (Kusel 1996). Another concern was that the term forest dependence did not reflect the local living traditions and sense of place held by many communities (Kusel 1996). This broader connotation is often what is implied by the term forest-based.

Increased Collaboration

A third underlying assumption was that increased collaboration with diverse stakeholder groups would lead to a consensus (or greater trust) that will allow for actions that can please a wider range of constituents. The past decade has seen improvements in the way in which stakeholders are involved in discussions of forest management decisions. Among the changes is an appreciation that even when people find forest practices acceptable, their judgments are almost always provisional rather than absolute or final (Stankey and others 2003a). These judgments and their durability are affected by people's trust in managers, their personal experience with place, their ideas about what "natural" is, the degree of risk seen in management actions, and people's reliance on their values or experiential knowledge in addition to scientific knowledge. This research suggests that even management decisions and actions supported by sound science will ultimately fail if social acceptance is lacking. The research also suggests several strategies to gain public acceptance (Shindler and others 2002):

- Treat social acceptability as a process, rather than an end product;
- Develop organizational capacity to respond to public concerns;
- Approach trust-building as the central long-term goal of effective public process;
- Provide leadership to develop a shared understanding of forest conditions and practices; and
- Focus on the larger context within which forest landscapes are managed, including risks and uncertainties.

In this context, forest management involves managing places that have multiple meanings to different stakeholders. Place-based management requires managers to use processes such as multi-party negotiation and collaboration, to give people the chance to express, negotiate, and transform meanings about places. Approaches that recognize the significance of place meanings take time but they can result in reducing conflicts over resource management saving time in the long run.

There is another aspect to collaboration, in an era of declining budgets the Forest Service is increasingly relying on partnerships with groups that share similar resource management goals. The Plan area has an extensive but informally linked network of staff working in the partnership arena. This broad network provides a tremendous asset by enhancing the effectiveness and delivery of regional programs of work. The paradox is that, budget declines serve as an incentive for expansion of collaborative processes, but these declines when they reduce agency capacity may also jeopardize collaborative efforts.

Federal Lands and Private Lands

The Plan's adoption altered the role that federal and private lands played in providing a broad array of environmental services and goods expected by the public. Adopting the Plan for federal lands was assumed to reduce pressure for stringent regulations for habitat conservation on private timberlands. In many senses, this assumption was correct and the experience in the Pacific Northwest demonstrates how ecosystem management approaches can be operationalized. The experience has also demonstrated the role of federal (or public) timberlands in the context of all timberlands, in providing the array of environmental services and goods the public expects.

A wide diversity of ownerships characterizes the westside of the Pacific Northwest (table 5-2). Unlike most other regions in the United States, forest ownerships in the Pacific Northwest tend to be made up of large and relatively contiguous blocks of timberland leading to an interest in landscape-scale management approaches. The wide diversity of ownerships, public and private, has led to a patchwork mosaic of management regimes spread across the landscape. The variety of management regimes stems in part from differences in individual landowners objectives, market conditions, biophysical productivity, and regulatory conditions within different parts of the region (see Haynes and others 2003 for a summary of management regimes by owner).

The importance of considering the potential of forests to produce a broad array of environmental services and goods has evolved and many of these services and goods are thought to be directly related to the structural conditions. The Pacific Northwest timberland base is structurally diverse and thought to be capable of producing a wide array of environmental services and goods. Looking broadly about half of the timberland base is less than 40 years old and half is more than 40 years old with 30 percent older than 80 years (these data are not available for the other public ownership class that includes the BLM) (Zhou and others 2005). The complementary nature of resource conditions and the contributions of various land owners are shown in figure 5-3 which illustrates the relative propensity of private timberland owners to provide early and mid-seral conditions while older stands are in the national forests. Data at this resolution masks concerns about the spatial juxtaposition of different seral stages but some of these concerns lack scientific rigor in their specification. The patchwork mosaic of management regimes (resulting from the diversity of land ownership objectives) spread across the landscape adds complexity to the various seral stages so that any stage is composed of relatively uniform to highly fragmented stands.

The implication of a broader look at forestland conditions is that the federal lands by themselves may not meet the goals of habitat conservation or the Montreal Process for sustainable forest management. All forestlands make a contribution towards achieving these broader societal goals. The Plan was an attempt to manage risks to late-successional and old growth related species and to prevent further

listings that might affect private and other public timberlands; in that sense the Plan succeeded.

The Timber Industry Would Survive

The timber industry was assumed to survive under the Plan and to adapt to changes in federal harvest flows. In general, it has although with some painful adjustments. Changes in the global forest products industry have helped mitigate some of the effects ascribed to the decline of federal harvest in the Plan area. The harvest decline in the Pacific Northwest (roughly 5 billion board feet) was offset by a combination of factors including harvest increases on private timberlands, increases in harvest in other regions particularly the U.S. South and the interior Canadian Provinces.[11] In addition, the collapse of the log export market from Pacific Northwest (log exports deceased during the 1990s by more than 2 billion board feet, log scale) and the loss of other export markets helped mitigate the effects (see Haynes 2003 for a general discussion).

Improving inventory conditions in the U.S. South and the loss of Pacific Rim export markets all contributed to higher domestic production mitigating any effects on consumers. These effects were always considered relatively small (estimated at $13 per household, FEMAT 1993). The U.S. total roundwood consumption increased by 4.5 percent during the past decade (11.6 percent for softwoods and -8.2 percent for hardwoods [Howard 2003]).

In the United States a transition is underway where, after 2015 most of all softwood timber will be harvested from managed stands (see the discussion [p. 121-123] in Haynes 2003). Most of these managed stands are on private timberlands, mostly in the U.S. South and in the Douglas-fir region (westside of the Pacific Northwest). In part, this transition from harvesting in natural stands to harvesting in managed stands has mitigated some of the harvest reductions on public lands. The transition will further reduce the role that federal timber plays in the U.S. forest situation.

The timber industry in the Douglas-fir region restructured during the 1990s, evolving into a highly efficient but less product diverse industry, focusing on lumber production primarily for the domestic market and using timber from private timberlands (see Barbour and others 2003, Haynes and Fight 2004). As such it focuses on 14-20 inch logs. Currently there is little capacity capable of handling logs over 24 inches in diameter. There is an evolving small log industry using logs between 4.5 and 10 inches small end diameter. Mills themselves are changing with the development of both very large mills (producing 300-400,000 board feet per shift) and specialty mills, some of which are relatively small (less than 50,000 board feet per shift).

It is still a large industry operating at a vast scale. In 2002, 13.44 billion board feet of lumber was produced in Washington, Oregon, and California. This rate of production required 1.68 billion cubic feet of logs or 1.4 million truckloads. The basic data for both the industry and example mill sizes are shown in table 5-3. The industry has developed in an integrated fashion to use both roundwood and residues (45 percent of each log ends up as mill residues). Until the early 1990s, the industry in the three states relied on federal timber for roughly 38 percent of their logs.[12] These logs came from federal timber sales that were sold using a mix of oral and sealed bidding. The Forest Service sold on a scale basis, and the BLM mostly sold on a lump scale basis. Timber sales were appraised to various end markets, mostly sawtimber, and included the value of residue products.

During the past decade many of the mills have moved. In the past they were dispersed across the region, and those depending on federal timber were generally less than 50 miles from where they bought timber. In the past decade the surviving mills (and new mills) have located along main transportation corridors and close proximity to the private timberlands where they procure timber. Now some rural areas though timber dependent have little local forest products manufacturing and logs harvested in the area are shipped to manufacturing centers further away (resulting in slightly lower stumpage prices than in the past) and reduced employment in spite of relatively high harvests.

The recent changes in the forest products industry has left some land managers wondering if local timber industry infrastructure can be maintained or re-established where it has closed during the last decade. To help frame this issue, table 5-3 illustrates how much wood (logs) is needed to sustain three typical types of mills in western Oregon and Washington. A medium size mill would need 16 truckloads of logs for each shift on each operating day. The production at this mill would generate enough chips to fill 13 chip vans every 2 days, which would need to be disposed of to a residue based manufacturing. In western Washington and northern Oregon, a pulp and paper industry is supported almost entirely from these residues. In the eastern and southern extremes of the northern spotted owl region, however, these residue based industries are less available which means that timber sales will depend on their sawlog components to be sellable because disposing of chips would be costly. The challenge to land managers is sustaining forest operations that can provide the magnitudes of log flows illustrated in table 5-3.

Changing Societal Values and Definitions of Old-Growth

The Plan's adoption implied some consensus in societal values. The evolution of the debate over old growth illustrates how tentative this assumption has proven to be.

The term "old growth" has sparked debate ever since scientists began to modify the timber inventory based definitions in the early 1980s. The divergent perspectives on old growth reflect differences that stem from differing social perspectives and political agendas. Old growth became a household word in the 1990s during the northern spotted owl debates, which captured the attention of Americans across the country. At opposite ends of the spectrum are forest managers and environmentalists. Some environmentalists may view old-growth as pristine wilderness and ancient forests that are home to precious and endangered species and that have spiritual values. Some forest managers see old-growth forests as valuable timber that may be wasted.

Increased knowledge about the Pacific Northwest forests has produced more definitions of old growth. Some scientists have indexed forest structural conditions along a continuum, rather than pigeonholing forests into simple categories of old growth or not.

These scientists prefer a multi-featured approach to locating stands on a continuum of structural and compositional complexity and diversity. These definitions vary in the age assigned to old-growth stands as well as in the use of ecosystem processes and forest structure and composition to describe old-growth.

In 1986, the Forest Service Old-Growth Definition Task Group described Douglas-fir old-growth forests as those with two or more tree species with a wide range of ages and tree sizes; six to eight Douglas-fir or other coniferous trees per acre at least 30 inches in diameter or at least 200 years old; a multilayered forest canopy; two to four snags per acre at least 20 inches in diameter and at least 15 feet tall; at least 10 tons per acre of fallen logs, including at least 24 inches in diameter and 50 feet long (Old-Growth Definition Task Group 1986 [PNW-447]).

FEMAT (1993) and the Northwest Forest Plan SEIS (USDA and USDI 1994a) used a different definition: old-growth forest stands are usually at least 180 to 220 years old with moderate-to-high canopy closure; a multi-layered, multi-species canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indicators of old and decaying wood; numerous large snags, and heavy accumulations of wood, including large logs on the ground.

In 2000, the National Research Council’s Committee on Environmental Issues (page 45) in Pacific Northwest Forest Management defines old-growth forests as those that support assemblages of plants and animals, environmental conditions, and ecological processes not found in younger (less than 100-250 years, depending on species) forests.

In current political debates, old growth in the Douglas-fir region is being defined as forests of natural origin older than 120 years and trees larger than 21 inches in diameter. These definitions are likely to be legislated in forthcoming laws and regulations. Little scientific basis exists for such laws but they reflect current societal values about cutting green timber on federal lands. The laws also represent a diminishing role of scientists in contributing to these definitions.

Governance of Forest Management Would Change

The Plan recognizes how the changing public appreciation of the array of services and goods provided by forests calls for a different way to govern forest management actions. In this context, governance is defined as exercising authority over actions and it has evolved in the Pacific Northwest from being market based to being a mix of market and regulatory functions (see Haynes and others 2003 for an expanded discussion). For federal forestlands, forest planning has been developed to implement forest management. It includes formal processes, broad management objectives, and increased stakeholder participation. Management on private forestlands is determined by a mix of market and regulatory functions. Different regulations (for example, State forest practice acts) influence both the design and applications of forest management practices.

For the most part, these regulations reflect a manifestation of public concerns about forest lands or forest conditions. These growing public concerns have long been a determinant of forest policies, and since the early 1990s, forest policy has increasingly been internationalized (see the discussion p.173-179 in Haynes 2003) in both the context of economic globalization and sustainable development. Currently much of the international debate deals with different suggestions about the need to supplement market determined actions with processes that try to find an equilibrium among interests advocating environmental protection, employment that contributes to economic prosperity, public access and social justice (see Andersson and others 2004 for a variety of perspectives on these issues).

The Plan's adoption for federal lands is an unique step in this evolution of shifting societal expectations for forest management. It takes an interagency approach and includes developing different institutions to supplement the existing mix of market and regulatory processes already present in the region. These institutions included a mix of formal and informal groups and organizations. Among the federal land management and regulatory agencies, the Regional Interagency Executive Committee (RIEC) and the Regional Ecosystem Office (REO) were established to oversee the implementation of the Plan. The role of the RIEC has expanded to provide a forum for discussing emerging problems beyond just implementing the Plan.

At the same time, implementing the Plan included developing several collaborative efforts whose success rested on involving both formal and informal groups. For example, the success of the adaptive management areas (AMAs) depended on developing an interchange among stakeholder (and local community) groups around specific land management actions in a specific place (see Charnley and others, in press b; Stankey and others 2003b). For the most part developing effective collaboration was difficult, both because of sufficient experimentation on the AMAs was lacking and little attention was paid to stakeholder engagement. Where successes were found, they depended on early engagement of stakeholders in the assessment part of planning and on fully involving them with the goal of gaining social acceptability for designed treatments. In some selected cases, engagement with informal groups led to partnerships that were able to accomplish specific actions collaboratively.

Another institution that was established in the ROD (USDA and USDI 1994b) was the provincial advisory committees which provided opportunities for coordination and information exchange at the province scale. The successes of these as effective institutions were mixed but they have provided an opportunity to engage other less formal organizations such as watershed councils. In 2000, resource advisory committees (RACs) were established; these are more formal organizations in both how they are composed and how they function. RACs are being effective in shaping ecosystem management decisions given their role in recommending (under Title II of the 2000 Secure Rural School and Community Self-Determination Act) road maintenance, watershed restoration, and hazardous fuels reduction projects. These organizations have been less successful in contributing to governance processes that influence all forest lands in the region.

Although not a formal institution, but one that has played a key role, stumpage markets during the 1990s have been highly volatile as landowners and forest products producers have adjusted to the reductions in federal timber flows (see Warren 2004, for various data series, and Haynes 2003 for a discussion of regional and national markets adjustments). Since the mid 1990s, stumpage prices have been either declining or stable, suggesting lower financial returns to various forestry practices. These lower prices may lead the many landowners, each with their own objectives, to respond in ways not supportive of sustainable forest management. As this happens, advocates for improved forest management (like the RIEC and the regulatory agencies) may find themselves supporting more regulation to ensure progress towards sustainable forest management across a broader number of forestland acres.

The Plan is one of the few experiments in developing an overarching framework for governing forestland management. It offers several lessons about how to develop alternative governance approaches than just depending on an uncoordinated mix of market and regulatory approaches. As societal expectations evolve for maintaining sustainable forestlands, overarching institutions like a RIEC and REO and others that may be developed can respond to and coordinate legal frameworks, decision making processes, land owner objectives, forest and land use policies. The experience in the Pacific Northwest suggests that developing these overarching institutions will be difficult given the diversity in landowner objectives, the propensity for rapid changes in societal values, and the difficulty of power sharing in a pluralistic society.

Treatment of Uncertainty

The original design of FEMAT did not address human prospectives of uncertainty and risk. From the past decade we now have a better understanding that these involve risk perceptions and attitudes (see Haynes and Cleaves 1999). Often, the public does not perceive risks in the same way as scientists or managers describe risks. The public often treats risks and uncertainy in a generic fashion where scientists tend to separate risks from uncertainty trying to predict the likelihood of some events with mathematical precision. For example, fire risks in the interior Columbia Basin can be computed as 1 percent per year (average number of acres burned per year divided by the number of forestland acres). Other events are too uncertain to reduce to a mathematical expression. Making decision in these two cases take different approaches but they also depend on the attitudes of decision makers toward risk. The human aspect of assessing uncertainties is how individuals express their risk attitudes; that is, the extent to which an individual seeks or avoids risks. For example, surveys of forest supervisors show them to be risk averse (Kennedy and others 2005). In risky situations they tend to choose the least risky direction. For example, in fighting a fire they are likely to overreact (adding resources) to increase the likelihood that the fire is controlled.

Finally, there has been some evolution in thinking about the tradeoffs between ambiguous gains in environmental conditions for nearly certain economic losses. The increased discussions during the 1990s stimulated largely by concerns around sustainable development have lead to a greater appreaciation that managing ecosystems involves managing a set of common property goods and services. This raises two issues. First there are the traditional economic arguments about how common property is abused rather than protected. Second the champions of civic society argue for greater attention for common goods.

In this context the Plan emphasizes viewing forest management decisions as involving broader environmental problems dealing with complex tradeoffs (or compatibility) among a broad set of environmental values including timber, wildlife habitat, aesthetics, biological diversity, water flows, ecological integrity, and recreation. As such it considers ecosystems as a set of commons whose goods and services are fairly available to anyone. Hardin (1968) laid out the common property issues involved in management in his classic article the Tragedy of the Commons. The essence of his argument was that if no one held property right to various goods and services, then there was no incentive to manage the resource to sustain production but rather to capture as much of the value as quickly as possible before others seized the various goods and services.

In addition to the economic implications, there is also a role for governance in assigning property rights to sustain various environmental services and goods. Here advocates for the role of civic society have pushed agendas that essentially attempt to assign property rights to various stakeholder groups who have traditionally been marginalized in market based approaches to resource allocation and management. The Plan is an example of habitat and old growth values being assigned greater worth than production forestry values.

Considerations

The political compromise leading to the Plan linked timber production on federal lands with jobs and community well-being. Since implementing the Plan, the debate has been generalized to imply that increased environmental protection threatens jobs and, therefore, community well-being. These issues framed the socioeconomic monitoring questions derived in part from President Clinton's five principles.

The socioeconomic monitoring effort associated with the implementation of the Plan was an enormous accomplishment. For the first time we have information about the effectiveness of a broad-scale forest management decision in terms of the key underlying questions. In general, the Plan enabled federal agencies to resume timber harvests. In terms of output levels, timber sale expectations were not met and there was a mix of effects on grazing and mineral activities and for recreation opportunities. Changes took place in all of the communities across the region, and while it is difficult to disentangle changes caused by the Plan from other changes there are still individuals who express a sense of lost social and economic opportunities. The mitigation activities that attempted to minimize adverse impacts on economic well being by assisting with economic development and diversification opportunities had generally positive effects. The overall growth in regional economies reduced many of the effects of reductions in federal timber flows. But attempts in the economic adjustment initiative to provide displaced workers with alternative forest based jobs were less successful than expected (this experience is similar to that in the Redwood Park experience (see Deforest 1999)).

The Plan engendered a new discussion among forest management advocates about what broad environmental values should be protected for future generations. These include protecting old-growth related species and many of the uses and values important to urban people. The monitoring showed that the uses and values that rural people associate with forests were not protected to the same extent. The Plan did engender considerable new collaboration between and among the federal agencies and public engagement in new forums.

This last decade has seen a broadening of societal concerns about forest management. Concerns used to focus on species conservation; now the emphasis is on achieving sustainable forest management across all forest lands. Social acceptance of forest management activites has also shifted, suggesting the importance of building and maintaining trust with citizens. Concern about community dependency has shifted to concern about community adaptability. The Plan has also demonstrated the importance of strengthening governance when implementing broad scale forest management.

Footnotes

[1] Forest management is at heart a process of managing a stand, collection of stands, or a forest to meet the objectives of the land owners. For private forestland owners, particularly those interested in financial returns (timber is considered a capital asset and part of an individual's portfolio of investments) their objectives often center on producing marketable goods, such as timber, hunting rights, and selected non-timber forest products like floral greens in an environmentally sound way. Public forestland managers typically have broader sets of objectives including producing both market and non market goods.

[2] In the United States retaining some forestlands (71 percent is private and 29 percent is publicly owned) in public ownership has been one attempt to impose broader sets of management goals than what might be expected from just market actions.

[3] Predictable levels of timber is used here in its generic sense of a known and expected flow of timber.

[4] The PSQ is the average annual estimate of the amount of timber that can be produced in the current decade and in every succeeding decade into perpetuity.

[5] The "owl forests" in the Pacific Northwest Region are the Gifford-Pinchot, Mt. Baker-Snoqualmie, Mt. Hood, Olympic, Rogue River, Siskiyou, Siuslaw, Umpqua, and Willamette. In the Pacific Southwest Region the owl forests include the Klamath, Mendocino, Six Rivers, and Shasta-Trinity.

[6] This comparison assumes that logging costs and difficulties are similar for both types of sales. If logging costs are higher for federal sales (because of different requirements), federal stumpage prices would be lower than for the other public land agencies. All data is from Warren (2004).

[7] This increased focus on adaptation and communities in transition will be discussed later, see Donoghue 2003, Donoghue and Haynes 2002 for additional details.

[8] Two examples of such efforts were the Executive memorandum on government-to-government relations with American Indian tribal governments. The White House, Office of the Press Secretary (April 29, 1994) and Executive Order 13175 - Consultation and coordination with Indian tribal governments Federal Register 65, no. 218. (November 9, 2000).

[9] The United States is a signatory to the Montréal Process Criteria and Indicators (1998) for Sustainable Forest Management. The Montréal Process includes seven criteria and 67 indicators and has been used to engage agencies, publics and advocacy groups in a discussion of what the available data can tell about the status, condition, and trends in U.S. forests (see USDA FS 2004 for more details).

[10] (As used here justice deals with a range of concerns including equitable power sharing in decision making, respect for property rights of indigenous communities, alleviation of

poverty and institutional capacity to support the conservation and sustainable management of forests).

[11] These shifts validated the warnings of those who said that federal protection for the spotted owl would shift the environmental consequences elsewhere. Economists call these types of effects "unintended consequences" and often argue that they demonstate policy failures in the sense of not having considered the full range of possible effects.

[12] Following the adoption of the Plan this proportion dropped to 15 percent.

Table 5-1–Expectations vs. results (5 objectives) region-wide

Objectives	Expected	Occurred	Differences	Differences caused by the Forest Plan	Differences caused by trends unrelated to Forest Plan
Produce predictable supply of timber sales, non-timber resources, and recreation opportunities	Federal agencies offer volumes of timber at Probable Sale Quantity (PSQ) and produce a predictable supply of timber and other goods.	Federal agencies did not meet average annual PSQ's over the decade. Grazing and mineral activity declined. Recreation opportunities remained relatively consistent.	Timber output was not produced at predicted volumes. Quantity of special forest products and grazing opportunities declined.	Executive, legislative, and judicial actions reduced the plan area available for timber production. Access restrictions impacted other activities.	Variability in timber and non-timber products markets led to changes in amounts of special forest products sold. Structural shifts in timber and beef industries affected grazing.
Maintain community stability and contribute to community well-being.	Community well-being is maintained by providing an even flow of goods from federal forests, including timber, non-timber forest products, services, and jobs.	Regionally, changes occurred for many communities. Well-being increased for about a 1/3 of communities, decreased for another 1/3, and remained the same for the rest.	Community well-being was not as dependent on providing an even flow goods from forests in most communities as expected.	For some communities decline in timber production caused hardship.	Growth in population occurred at the same time as the increases in educational attainment. Some communities were more resilient than others.
Assist with long-term economic development and diversification to minimize adverse impacts associated with job loss.	Where timber sales could not proceed, NEAI would provide immediate and long-term assistance to minimize adverse impacts associated with job loss.	The number of timber industry jobs lost exceeded expectations. NEAI provided less help to displaced workers than expected.	Loss of agency jobs caused a significant decline in social capital in forest communities. The Jobs-in-the-Woods program was not as effective as planned.	Greater declines in federal workforce than expected. Restoration activities were not carried out as vigorously as planned.	Agency budgets declined. Changes in other state programs affected economic development. The continuing diversification of the U.S. economy has local impacts.
Protect forest values and economic qualities associated with	Reduce litigation, appeals, gridlock over forest management actions by	The uses and values that urban people associate with forests were	Gridlock increased because the Plan failed to engender public	Plan raised public expectations for habitat conservation and	Rural urban environmental values continue to evolve. Growing

late successional old growth and aquatic ecosystems	protecting the uses and values that people associate with these ecosystems.	protected. The uses and values that rural people associate with forests were not protected as well. All “old growth” was not protected.	trust.	passive forest management.	emphasis on sustainable forest management.
Promote interagency collaboration and agency-citizen collaboration in forest management	Enhanced collaboration among federal agencies and between agencies and citizens in resource management.	Public engagement in new forums of collaboration delivered benefits to communities. Interagency collaboration improved.	Some citizens were disappointed in the loss of local control in decisions.	Region-wide focus of the plan diminished the importance of local issues and local constituencies.	Broadening public interest in environmental conservation has increased the interest in collaborative approaches.

Table 5-2—Forest land area in the United States Pacific Northwest-westside, 1997

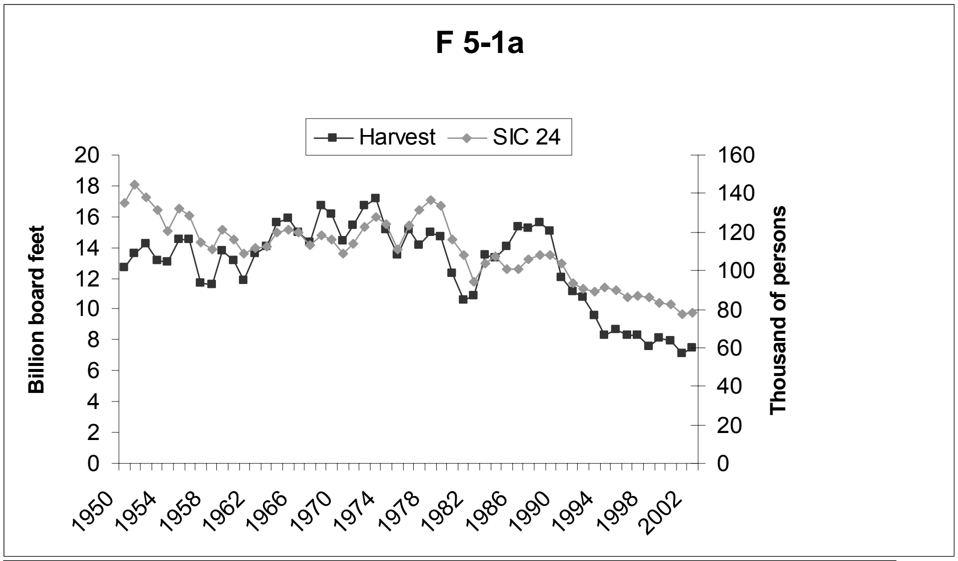
Land class	Total	National Forest	Other Public	Forest Industry	Nonindustrial Private
			Million acres		
Total forest land	27.270	8.912	6.283	6.960	5.115
Nonreserved					
Timberland	23.297	7.134	4.572	6.837	4.755
Other	.692	.040	.173	.122	.357
Reserved – Total	3.281	1.748	1.539	--	.004
Nonwilderness		.174			
Wilderness		1.564			

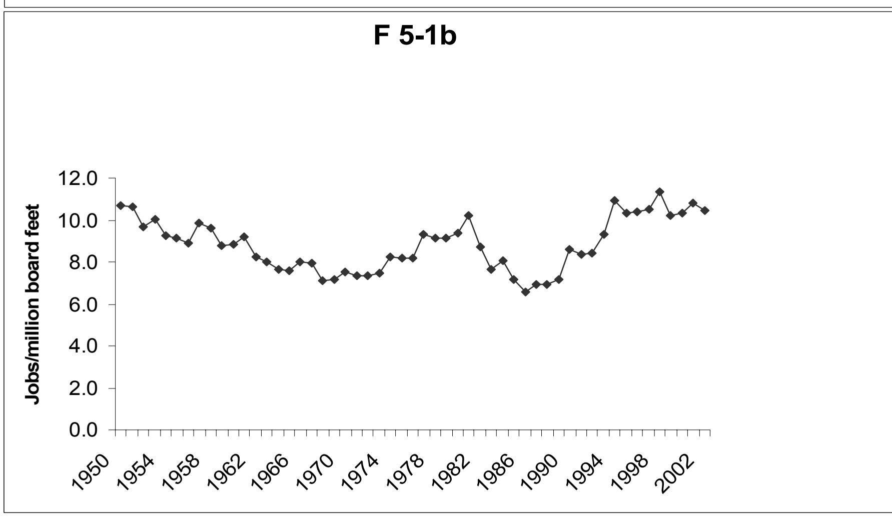
Table 5-3—Wood requirements for one small, one medium, and one large sawmill and for the total industry, 2002

	Units of measure	Small sawmill	Medium sawmill	Large sawmill	Total industry
Production/shift	Thousand board feet, lumber scale	50	150	400	
Annual 1 shift production[a]	Million board feet, lumber scale	12.5	37.5	100	13,436
Chip, sawdust production[b]	Million cubic feet	.7	2.1	5.6	755.8
Annual log requirements[c]	Million board feet, log scale	6.25	18.75	50	6,718
Annual log requirements[d]	Million cubic feet	1.56	4.67	12.5	1,679.5
Log truckloads[e] per year		1,302	3,906	10,417	1,399,583
Chip vans per year[f]		549	1,648	4,394	590,449

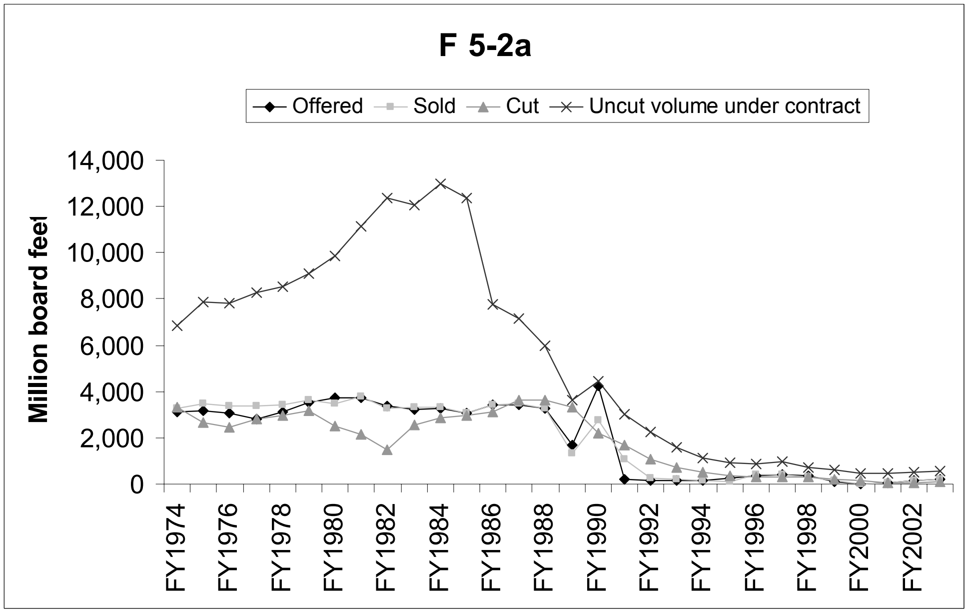
[a] Annual production is computed assuming 250 operating days.
[b] Chip production computed as 45 percent of log input volume (in cubic feet).
[c] Computed assuming an overrun of 2 (there is 2 board feet of lumber scale for every board foot of log scale, scriber scale).
[d] Cubic volume computed assuming 4 board feet (log scale) per cubic foot.
[e] Computed assuming 1,200 cubic feet of logs per truckload.
[f] Computed assuming 16 units per truckload and there are 2.5 cubic feet of pulp chips per cubic feet of solid wood.

Figure List

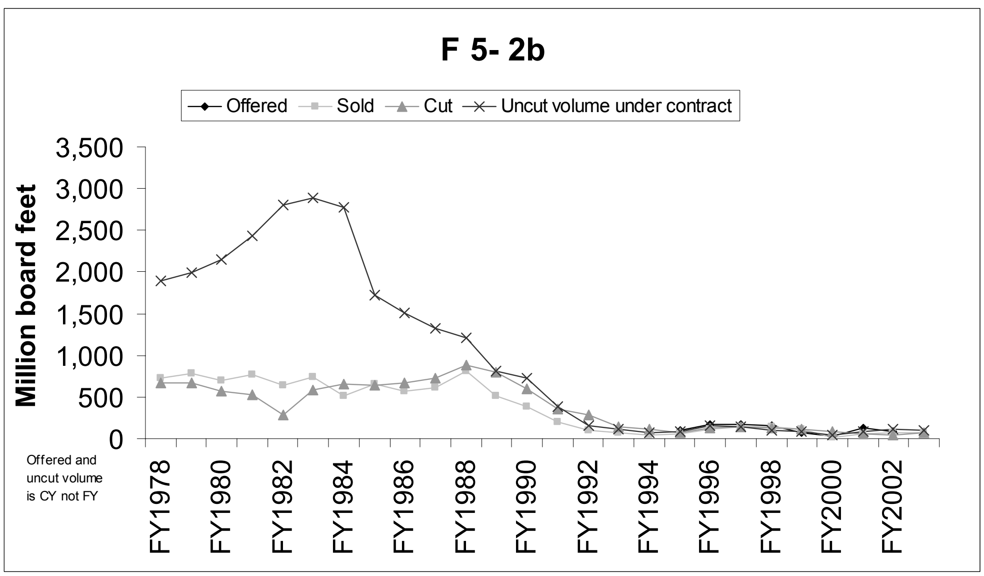




Source: 1950-1965 Smith and Gedney 1965, 1966-2002 is from Warren 2004.



Source: Warren 2004.



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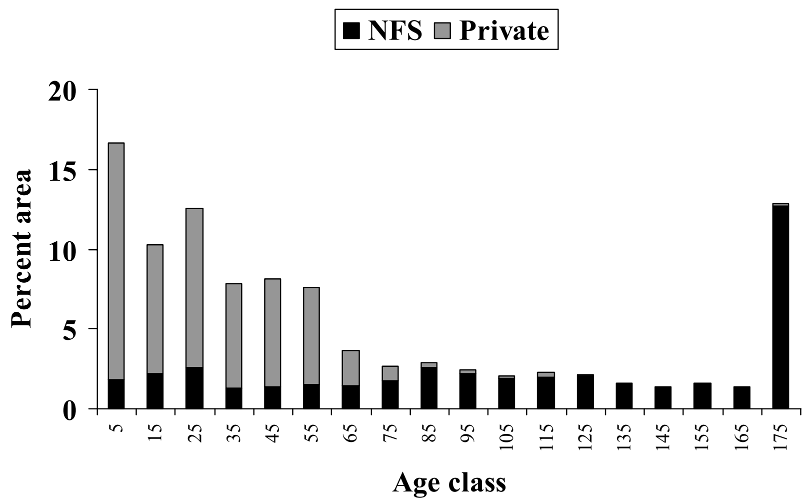

Source: Haynes and others 2003.

Chapter 6: Maintaining Old-Growth Forests

Thomas A. Spies

Introduction

The forest ecosystem management assessment team (FEMAT 1993) was directed to develop alternatives that met this objective, among others:

Maintenance and/or creation of a connected or interactive old-growth forest ecosystem on the federal land within the region under consideration.

The FEMAT produced several alternatives, one of which, option 9, was selected by the President as the basis of the Northwest Forest Plan (the Plan), described in the Record of Decision (ROD) (USDA and USDI 1994b). To a large degree the success of the Plan depended on the structure, composition, and dynamics of forest vegetation. In this chapter, I describe the general and specific expectations of the Plan, what has happened, and what we have learned from monitoring. Critical Plan assumptions are reviewed in the context of recent science findings and new perspectives, and alternative approaches to meeting the Plan's goals are discussed.

The terminology associated with the concept of old growth is often confusing. Other terms associated with old-growth forests have included: mature forest, old forest, older forest, and late-successional. In this chapter, "mature" forests refer to the stage of stand development that occurs just prior to the old-growth stage (fig. 6.1, 6.2), "older" forests encompasses both mature and old-growth stages and is the term used in the status and trends report (Moeur and others, in press) for the general set of different inventory definitions. "Late-successional" has also been used in FEMAT and the ROD for these later two stages of stand development, but its usage in the Plan is somewhat confusing. In this chapter I will use "older" forest as it was used in the status and trends report. Some authors will use the term "old forests" as a substitute for "old growth", if they consider that term too limited (e.g. only forests with massive old trees) or too value laden. I will use "old-growth" to refer to the last stage of stand development that is typically associated with stands with large old trees and complex structure (fig. 6.3-6.6). I present a more in-depth discussion of definitions and the ecological concepts of forest development later in the chapter.

What was Expected?

The assessment of the state of old-growth forests was based on the assumption and observations (Bolsinger and Waddell 1993) that amounts of old-growth forest had steeply declined during the 20th century, placing associated species at risk and reducing the contribution of old-growth forests to ecosystem functions such as carbon storage and the hydrological cycle. The obvious correction for this problem was to develop management policies that reduced the rate of loss of existing old-growth forests and at the same time promoted the growth of new areas of older forest. Because the problem is rooted in the loss of old-growth forest, relative to past amounts, the solutions under the Plan were based on returning the federal landscape toward an extent of old-growth forest more in line with what was here before widespread logging on federal lands. The historical extent was assumed to be adequate to sustain the native biological diversity associated with older forests. To do this, the amount of the historical landscape covered by older forests in the past had to be estimated. The answer to this question, however, was not as simple as determining how much older forest occurred at some past point or period in time, such as the early 1800s before Euroamerican settlement. Forests are dynamic as a result of disturbance, growth, and succession, consequently, the abundance of older forests varies over time—no single point or short period can realistically be used to characterize this dynamic system. Under the historical natural disturbance regime (type, severity and frequency of disturbance), the amount of particular young and old forest stages can vary from 0 to 100 percent of small landscape or watershed. At larger spatial scales, the amounts of different seral stages typically have a more restricted range of proportions because most disturbances do not cover entire provinces or regions (Wimberly and others 2000). For example, the amount of old-growth forest in Coastal Oregon was estimated to range between about 30 and 50 percent of the province under the historical fire regime (Wimberly 2002). This range is termed the historical range of variation (HRV) (Landres and others 1999). This reference to historical disturbance regimes was used in characterizing the potential outcomes of the options considered in FEMAT (1993: IV-49 to IV-51).

The expert panel assessments in FEMAT were based on outcomes for older forest described in terms of historical abundance and diversity, ecological processes, and spatial pattern or connectivity under the historical disturbance regimes of the region. For example, the outcomes for abundance and diversity were described as: (1) at least as high as the long-term average amount of late-successional forest; (2) below the long-term average but within the historical range that would be expected under past disturbance regimes; (3) considerably below the low end of the historical range of conditions; and (4) very low in abundance and may be restricted to just a few provinces or elevations within a province (FEMAT 1993: IV-49 to IV-53). The panels characterized the options by the likelihood that the policy option would lead to the outcomes described above. This characterization was done separately for the moist provinces, where fire frequencies were relatively low, and for the dry provinces, where fire frequencies were relatively high. For the moist provinces, the panels estimated a 77 percent likelihood of achieving outcome 2 under option 9; for dry provinces, this likelihood dropped to 63 percent.

The assessments (FEMAT 1993) set the general expectations and context for older forests under the Plan: it will probably lead to an outcome in which the abundance and ecological characteristics of late-successional forests at the scale of the Plan area fall within the range of what might have occurred under the historical disturbance regimes of the past; significant uncertainty exists about outcomes over the life time of the Plan; the uncertainty in outcomes is especially high in dry provinces, where decades of fire suppression makes it difficult to achieve outcomes based on disturbance regimes of the past.

What are the Status and Trends and what Differences were found Between Expectations and Observations from Effectiveness Monitoring?

The older forest status and trends report (Moeur and others, in press) provides a wealth of information over the Plan's first 10 years. That report maybe the most comprehensive monitoring of old-growth conditions that has ever been written. Despite the richness of the data sets, the time monitoring frame is only 1/10 of the 100 year time frame of the Plan, 1/20 of a 200 year return interval between lethal fires typical in some areas, and only 1/100 of the potential maximum age of a Douglas-fir tree. Consequently, these trends should be viewed with caution because they could be quite different in the next 10 year period.

The specific outcomes and expectations for older forest under the Plan can be divided into three major areas: abundance and diversity; process and functions; and connectivity.

Abundance and diversity—

Most of the findings from the status and trends report (Moeur and others, in press) are related to the abundance and diversity of older forests, where “older forests” is the term used to refer to mature and old-growth stands. The following findings are especially significant:

- The estimate of the amount of older forest depends on which structural definition is used—adding more structural criteria to the definition, would reduce the area of forests that meets a definition because not all older forest stands possess all of the structural features associated with the general population of older forests.

- The area of older forest (as defined by medium- and large-diameter trees (> 20 inches and 29.5 inches in diameter, respectively) with simple or complex canopies) on federal lands estimated from remote sensing at the Plan’s beginning was within 10 percent of the value estimated in the recent monitoring analysis, which was based on improved remote sensing models and inventory plots.

- The Plan assumed that most of the remaining older forest in the Plan area was on federal lands. Though some provinces have some significant areas of mature forest (medium and large diameter trees) on non-federal lands, nearly 80 percent of the largest and most structurally complex class occurs on federal lands. This assumption is supported by the new inventory information (table 6-1), which confirms estimates of earlier inventories (Haynes 1986, SAF 1984).

- Thirty-four percent of the federal land base was covered by older forests with medium to large trees and simple to complex canopies. The amount of older forests with very large trees and complex canopies covers about 12 percent of the federal land base and is concentrated in forests west of the Cascade divide.

- The reserve system captured the most structurally complex portion of the remaining older forest, for example, the proportion of large multistoried old forest in reserves was nearly twice as high as in matrix lands.

- Losses to older forest from stand-replacement natural disturbances, such as fire, were actually less than what was expected for the Plan area (0.18 percent vs expected 0.25 percent (FEMAT 1993) as a whole. However, within several of the dry provinces rates of loss of older forest to wildfire where much higher than the overall average and these provinces accounted for most of the losses to high severity wildfire.

- The average net increase in older forest with a quadradic mean diameter (qmd) of >20 in (1.9 percent average annual increase in the area of old forest) since the plan began was higher than the 1.2 percent annual net increase expected in the ROD (the ROD estimate did not include California).[xiv] Some of this higher rate of increase was because much less old forest was cut in the matrix than the Plan originally called for (Baker and others, in press). This lack of logging, however, accounts for only about one half of the higher net rate of increase. If logging of old forest in the matrix had occurred at the expected rate of 800 million board feet per year, I estimate that the net rate of increase of older forest would have been reduced by about 19,000 ac/yr or about 0.3 percent per year. (This assumes a volume removal of about 42,000 board feet/ac).

- Rates of loss of older forest varied widely among provinces; annual rates of loss to high severity fire ranged from 0.05 to 9.5 percent in dry provinces and 0.0 to 1.4 percent in wet provinces (table 6-2).

- Fifty-five percent of the area of older forest types occurred in climatic zones and vegetation types, in which relatively frequent low-severity fire or thinning is needed to maintain desired old-forest structures and to reduce the probability of high-severity fire (table 16 in Moeur and others (in press)).

The status and trends results for abundance and diversity should be viewed with several cautions. First, the remote sensing and inventory plot data are not a complete picture of the ecological characteristics of the older forests of the region. Only broad classes of canopy size and canopy patchiness were used in inventories. Information about numbers of large trees, subcanopy trees, and large pieces of dead wood, for example, were not included. A more comprehensive analysis might reveal a different picture.

Second, the area lost to timber harvest logging (16,900 ac) and wildfire (102,500 ac) is probably underestimated because only disturbances greater than five acres in size were analyzed. In contrast, a USFWS report (2004) estimated that almost 156,000 acres of owl habitat were lost to timber harvesting between 1994 and 2003. The USFWS estimate is almost certainly too high because it was based on timber harvest plans that were submitted by the USFS and BLM during consultation and the agency does not typically update its data base for what was actually implemented (Jim Thraikill, personal communication). A large number of projects to harvest older forest in the matrix lands were not implemented because of legal challenges and other factors (Baker and others, in press). Furthermore, federal forest managers frequently submit plans that overestimate the area of owl habitat affected by project activities to give themselves flexibility in the implementation stage (Neil Forrester, personal communication). Although the remote sensing based change analysis can not detect very small patch disturbances, it has relatively high accuracy (88 percent) for small to large stand replacement disturbances (Cohen et al. 2002). Because most timber harvesting plans in older forest in matrix lands would use cutting units larger than 5 acres, the change analysis probably does not underestimate loss by a large factor.

Third, the net changes in older forest come largely from the gradual growth of the diameter of stands into the lower end of the 20 inch diameter class and not much from the development of old-growth forests with very large trees and complex structure. The relative high percent increase comes in part because of a bulge in the size-class distribution of forests with diameters just below the 20 inch class. As this bulge moves into the > 20 inch class, rates of increase in this forest size class will decline. Given the limitations of the change analysis we do not know the actual net changes in old growth forests that occur from losses to fire and timber harvest and increases from the development of mature forests into old growth forests.

Processes and functions—

The effectiveness monitoring program was not designed to provide information about the status and trends in the processes and functions of older forests. Processes refer to ecological dynamics that lead to development of maintenance of old-growth forests. For example, rates of succession, gap formation, low-severity fire, productivity, decomposition and so on are all important to the development of old-growth forests. Some processes trends can be inferred, however. For example, the amount of low-severity fire in old forest in dry provinces is probably not enough to sustain old forests (e.g. Ponderosa pine) that depend on fires with frequencies of less than 35 years (Agee 1993). Little data were available to support this hypothesis, but historical rates had occurred fires would have been widespread throughout the forests in these provinces. Data from the implementation monitoring report (Baker and others, in press) suggested that the area of forests treated to reduce understory fuels either through prescribed fire or mechanical means was not high. The rates of other processes such as gap formation, regeneration, and nitrogen fixation are not known. The effects of invasion by non-native species on old forest development are also unknown.

The functions of old forest are those ecological characteristics that are of value to other organisms or humans. For example, old-growth forests provide ecological legacies (e.g. large live and dead trees) for organisms that use open and young forests that develop following stand-replacement disturbances (McIver and Starr 2000). This function is operating largely as it would have under a natural disturbance regime. This observation is based on the assumption that few acres of old forest killed by stand-replacement disturbances (more than 120,000 acres) were salvaged logged, which would have been the standard practice when timber production was a major goal on the federal lands. We know little about other potential functions of older forests such as production of clean water and nitrogen fixation.

Connectivity—

Connectivity in the Plan refers to the degree to which the spatial distribution of older forest provides for movement of plants and animals between old forest patches. Connectivity can be measured in many different ways and does not necessarily mean that the patches of forest need to be physically connected to each other by old forest. Most organisms can disperse across areas that are not prime habitat, but some are better disperses than others. The FEMAT defined connectivity in terms of distance between areas of older forest and the portion of older forest in the landscape. The expected outcome for connectivity was that the distances between large blocks of late-successional forest would be less than 12 miles on average (FEMAT 1993: IV-52). The status of connectivity over the entire region depends on the definition of old forest and the process examined. Connectivity for the mature and old types together appears moderate to strong, based on the fact that the distance of large blocks of this type average was 6 miles apart for most provinces and that the proportion of the landscape in old forest is above 25 percent. When older forest was defined more restrictively, i.e. LMS, then connectivity was less but still within 12 miles for most provinces, except the California Coast.

Are the Plan's Assumptions and Approaches Still Valid?

The Plan was based on many assumptions about natural forest ecosystems, management effects, and forest dynamics. If these assumptions are no longer valid it could mean that the Plan will not work as intended, that it might be modified to achieve its goals, or even that the goals should be changed. The assumptions could change for several reasons: first, the status and trends of old forest might not be what was expected; second, new scientific findings could emerge from work outside of the effectiveness monitoring program that would change the validity of underlying assumptions; third, new perspectives about forest ecosystems might have emerged from new interpretations of existing scientific information. In reality, our assumptions about ecosystem management plans often change as a result of both new research studies and new interpretations. The status and trends summarized in the previous section do appear to meet Plan expectations. In the following sections I address new scientific findings and perspectives that might be relevant to the success of the Plan.

Old-Growth Forest Definitions

The Plan used the term “late-successional/old-growth” to describe the older forest conditions that were of concern. This term includes the mature and old growth stages of stand development, where old growth is defined as a stand containing large live and dead trees, a variety of sizes of trees, and vertical and horizontal heterogeneity (6.3-6.6). The mature stage of development occurs as trees approach their maximum height and crown diameter but lack the heterogeneity of older forests (fig. 6.1, 6.2). In Douglas-fir forests the old-growth stage typically occurs at 150 to 250 years after a stand-replacement disturbance and can persist with slow changes for an additional 500 years or more (Franklin and others 2002). The mature stage typically begins around 80 to 120 years of age in Douglas-fir forests. These age ranges and degree of structural development may differ in other forest types in the region. The mature stage of stand development was considered in FEMAT along with old growth because it could develop into old-growth conditions within the lifetime of the Plan, it can be structurally and compositionally similar to old growth, and, in some areas, the most ecologically valuable large patches of uncut forest were in the mature stage of stand development. Many of today’s mature forests will become the old-growth of the future and are needed to maintain old growth over time.

Use of the term “late-successional” to describe the set of older forests has caused some confusion. It was really intended to refer to both the mature and old-growth stages of development but it is frequently used as if it were a stage that is separate from old growth, i.e. the mature stage. This usage is confusing because the mature stage of forest development is actually not as successionally advanced as old-growth. The status and trends report of Moeur and others (in press), uses the term “older forests” to refer to the mature and old-growth stages. This term is simpler and more descriptive of the conditions of mature and old forests than is the term late-successional.

Another source of confusion stems from the two different ways that plant ecologists conceptualize vegetation change over time following stand-replacement disturbance: succession and stand development (Frelich 2002). Succession typically refers to a directional change in species composition over time where one or more species replaces others. Generally the species that come later are more shade tolerant and are often referred to as late-successional species, because they can regenerate in canopy gaps an maintain themselves within closed canopy forests in the absence of stand-replacement disturbance. Stand development refers to population/structure changes as forests age. Stand development may or may not be accompanied by a change in species composition. For example, fire in ponderosa pine forests may simply regenerate new populations of ponderosa pine but not change species composition. Consequently, it is possible to have old-growth (an aging population of trees and associated structures) that composed of early successional species (e.g. ponderosa pine, aspen) and old growth that is composed entirely of late-successional species (e.g. western hemlock, or grand fir). One could distinguish early successional old growth from late-successional old-growth.

The ecological characterization (with the exception of the terminology) of older forest in the Plan is generally valid, but since then researchers have become aware that the diversity and complexity of natural forests is greater than some of our conceptual models have portrayed. Our general scientific model of older forests and forest dynamics in general has become more refined as a result of studies of old-growth structure in Douglas-fir and other forest types (Youngblood and others 2004), old-growth stand development (Ishii and Ford 2001, Poage and Tappeiner 2002, Tappeiner and others 1997, Winter and others 2002) disturbance history (Weisberg and Swanson 2002) and from new perspectives on forest complexity and stand development (Franklin and others 2002, Spies 2004). Collectively, these studies lead to several important observations about older forests, which are described in the next several paragraphs.

Old growth is part of a multivariate continuum of forest structure and composition, and breaking this continuum up into classes is arbitrary (Spies 2004, Spies and Franklin 1991). This continuum can be divided into classes in various ways, and a larger variety of classes may be needed to capture the diversity of types than had been used previously (Franklin and others 2002).

For Douglas-fir forests, old-growth characteristics typically begin to emerge at 150 to 250 years following stand-replacement disturbances. These characteristics include trees greater than 39.4 inches d.b.h., associated lower and midstory shade-tolerant trees, large dead trees (>49 feet tall and 20 inches d.b.h.), large fallen tree boles on the forest floor, a diversity of heights of foliage, and patchy distribution of canopy gaps and understory vegetation. On high productivity sites, some of these characteristics can begin to appear as early as 100 years. Where the initial disturbance was patchy, structures characteristic of older forest can emerge much earlier, sometimes as soon as 80 years depending on how much was killed in the initial disturbance. Age can be a rough approximation for old-growth stands in the northern and coastal provinces of the Plan area where disturbances are relatively large and kill most of the trees. Where disturbance regimes are characterized by patchy low to moderate severity fires, however, stand age is not a very useful measure of old growth characteristics.

Old-growth structure and composition can change over time within a stand. For example, in the dry provinces old-growth ponderosa pine can succeed to old-growth pine and fir.

Not all old-growth forests share all of the same attributes or have the same expression of structural complexity. For example, fire prone old-growth ponderosa pine forests have relatively open understories and patches of regeneration, while old-growth mixed conifer forests in the same landscape have dense understories. These structural compositional differences affect stability, resistance and ecological characteristics. For example, in the absence of fire, open, old-growth ponderosa pine forest can develop into dense mixed conifer forests that have a lower resistance to high severity forests than fire-dependent pine old growth.

Old growth is a complex ecological concept that requires a multiscale perspective ranging from individual live or dead trees, stands or patches, landscapes, to whole regions. At broad scales, the old growth is clearly part of a mosaic of open, young and mature forest types. A comprehensive strategy, which is currently lacking in the Plan, to conserve any one stage of this mosaic requires considering all stages (Spies 2004). Although the structures associated with these old-growth (e.g. large live and dead trees, patchiness) typically develop and appear in old stands they can also be found in young forests as survivors of disturbance. Thus, the ecological contributions of old growth can occur in stands of all ages.

Given the complexity of forest development and the concept of old growth, definitions used by inventory (Moeur and others, in press) can only be approximations. Inventory amount and distribution of old-growth forests by all of the attributes that have been associated with them by using the same inventory tools is impossible. For example, remote sensing can estimate the size of trees in the upper canopy and characterize spatial patterns but it cannot estimate dead wood and understory patchiness. Inventory plots can be used to characterize the size distribution of live and dead trees, but it cannot measure spatial pattern. Inventory information is a composite of surrogates from remote sensing (e.g. size of canopy trees) or non-spatial structural information from inventory plots (dead wood and tree size distributions). For this reason the monitoring plan recommended a two-pronged approach—remote sensing and inventory plots—to assessing the amount and distribution of forest conditions (Hemstrom and others 1998).

The new perspectives on old-growth complexity underscore the need to adjust conservation and management strategies to forest types and environments. For example, old-growth goals and strategies could vary by provinces, potential vegetation types (plant association groups) and disturbance regimes. The Plan recognized this complexity to some degree but more could be done to incorporate it into practice. For example, specific older forest definitions are lacking for dry old forest types and for younger forest stages or mixes of younger and older forests. Clarification of the definitions of older forest stages and their significance to the Plan is important for the following reasons:

The Plan is based on conservation of a particular stage or stages of older forest. Without a clear definition or set of definitions, the goals of the Plan become confusing and difficult to communicate.

Because forests are dynamic systems, conservation of a single stage, even a long-lived one, is really impossible without considering other stages and transitions among them. For example, many of today's mature forests will be the old-growth forests of the future, and today's old-growth forest may be the early successional forest of the future. If the Plan focuses to exclusively on one or more older stages, it may not sustain native biological diversity associated with old and young forests that occurs outside of those stages.

Current Amounts of Old Growth Compared to the Historical Conditions

Conservation concerns about biodiversity in this region stem from the observation that amounts of old growth and associated forest structures (large live and dead trees) have declined strongly over the 20th century as a result of logging and wildfire (Bolsinger and Waddell 1993). Fire suppression has also contributed to the loss of some fire dependent old-growth types. References to past forest conditions can be problematic, however, because forest landscapes are dynamic and the amount of any particular forest compositional and/or structural type will vary depending on the time and location of the observation. Recognizing these inherent dynamics, ecologists have developed the concept of historical range of variation (HRV) which is the range of variation in forest attributes that might be expected in a landscape over time under a particular disturbance regime (e.g. frequency, type and severity) (Landres and others 1999).

Historical range of variation in forest age or stage classes can be a useful context for understanding the state of present day landscapes (Agee 2003, Wimberly 2002). For example, the percentage of old forest (forests > 200 years old) in the Oregon Coast Range was estimated to range between about 25 and 75 percent of the forest area

(Wimberly and others 2000). For forests more than 80 years old they estimated the range was from about 50 to 85 percent. Today, the amount of old-growth forest containing 39.4 inches diameter trees, size diversity, and large amounts of stand and fallen dead wood is estimated to be around one percent of that province (Ohmann and others, in prep.). (The smaller proportion of old growth in Coastal Oregon estimated by Ohmann and others compared to Moeur and others, in press, probably results from the fact that Ohmann used a more restrictive structural definition.) In the central eastern cascades of Washington, Agee (2003) estimated that, multi-storied old-growth forests covered 38 to 63 percent of the landscape. Comparable estimates of current amounts were not made in that study. Moeur and others (in press) estimated however, that the percentage of older forest in the eastern Cascades of Washington--an area that encompasses the Agee (2003) study--was about 12 percent with older forest defined as medium and large trees, whose diameter limits vary species and site productivity.

The HRV was used in the ecosystem assessment in FEMAT to describe possible Plan outcomes. But the original evaluations of various options showed that reaching that range may not be possible in future landscapes given possible changes in climate and disturbance regimes. The concept of variation in amounts of old and young forest overtime does have value in understanding the degree of change that has occurred and in setting general expectations for landscapes, where native biodiversity is a dominant management goal. Even with disturbance regimes and climate change a range of forest ages/structures will typically be present in landscapes over time if disturbances are spread across all stages and do not happen exclusively in older forests, which would usually be the case under natural disturbance regimes including fire, wind, insects, disease.

The HRV studies have shown that landscapes the size of large National Forests (i.e. > 1,235,527 acres) were unlikely to be completely covered by old forests (Wimberly and others 2002). For example, in the Oregon Coast Range, a mosaic of open, young closed canopy and older stages were more likely (Nonaka and Spies, in press). Current policies on federal lands in wetter provinces could lead to more old growth than would be expected under the historical wildfire regime.

History of Development of Old-Growth Stands

Several studies in the Pacific Northwest have examined how old-growth stands have developed over time (Poage and Tappeiner 2002, Weisberg 2004, Winter and others 2002). In the moist provinces these studies where they confirm the model set forth by Franklin and Hemstrom (1981) of stands with a wide range of ages of the dominant Douglas-firs, implying slow establishment after fire, a history of moderate severity fire that results in regeneration of Douglas-fir, or both. Studies of stand development history are less common in the dry provinces. Where studies have been done, the range of age variation in the older trees is wide; old trees established almost continuously over several centuries as a result of frequent low-severity fires (Sensenig 2002).

Studies also indicate that many old-growth stands in the moist provinces developed from young stands with low stem densities compared with today's forest plantations (fig. 6.7). The densities of young stands will influence the diameters of the trees when they reach old age (Poage and Tappeiner 2002). Not all stands developed with multiaged old trees; some older forests have relatively uniform aged stands (Winter and others 2002), although this pathway seems to be less common across the Plan area than the multiaged pathway.

Much has been learned in the last 10 years about the diversity and role of fire in developing of old growth. Increasingly, the variation in disturbance regimes across the Plan area is appreciated (Brown and others 2004, Sensenig 2002, Weisberg and Swanson 2003). Although the role of fire in creating structural complexity in old growth was known for the dry types with frequent fire return intervals. The role of fire in the west side was less appreciated. Typically, fire on the west side was largely seen as a destroyer of old growth. Recent research (Weisberg 2004) confirms the understanding that fire in mixed fire regime landscapes on the west side contributes to the particular spatial pattern and structure of old-growth Douglas-fir and western hemlock forests.

Silviculture to Restore Ecological Diversity and Accelerate Old-Growth Development in Plantations

The effects of thinning on the long-term development of old-growth characteristics in plantations are understood only from modeling studies and just a few years of experimental work. Retrospective studies of old-growth development have also provided insights useful to understanding how silviculture might affect old-growth development (Tappeiner and others 1997).

Results thus far show that thinning plantations is an important to restoring structural and compositional diversity on federal lands. Dense young plantations (fig. 6.7) have lower species diversity than more heterogeneous young stands, and they may not develop old-growth characteristics like large trees and complex canopies as rapidly as less dense young stands. Thus, the goals of thinning are really two fold: diversify young stands now and accelerate the developing of old-growth characteristics in the future.

The literature supports the practice of thinning to increase species diversity in stands (Muir and others 2002). Many ecologists believe that thinning for biodiversity goals should seek to promote spatial heterogeneity in stands, rather than the uniform spacing and density of trees produced in thinning for timber production. Spatial variation in stand density creates a diversity of microsites and promotes species diversity. Leaving some areas of stands unthinned is important to provide the shaded microclimates favored by some species. For example, some species of bryophytes have been shown to decline in thinned areas compared with unthinned areas (Thomas and others 2001). The most effective spatial patterns of thinning in young stands to create ecological diversity are not known and probably vary across the Plan area. Caution needs to be exercised in applying the same spatial pattern of thinning in all areas and at all spatial scales, since scientific research on this practice is only in the early stages.

The effects of thinning on development of old-growth characteristics in plantations are only partially understood. Certainly, the growth of trees into larger diameter classes will increase as stand density declines (Tappeiner and others 1997). At some point, however, the effect of thinning on tree diameter growth levels off and, if thinning is too heavy, the density of large trees later in succession may be eventually be lower than what is observed in current old-growth stands. In some cases, opening the stand up too much can also create a dense layer of regeneration that could become a relatively homogenous and dominating stratum in the stand. Furthermore, if residual densities are too low, the production of dead trees may be reduced (Garman and others 2003). Thinning should allow for future mortality in the canopy trees. Modeling studies indicate that thinnings in plantations could accelerate development of some old-growth characteristics by as much as 60 to 80 years, depending on the thinning regime and the age of the plantation at initial entry. Multiple thinning entries typically had more effect than a single entry.

Data from implementation monitoring (Baker and others, in press) are not adequate to evaluate the degree to which thinning operations were conducted in plantations in late-successional reserves. The implementation report indicates that a total of 287,414 acres were treated with partial removal which includes commercial thinning but not precommerial thinning. If we assume that 30 percent of the late-successional reserves (based on the fact that most reserves contain a significant area of plantations) are in plantations suitable for thinning, then 2.2 million acres would be potentially eligible for thinning at the beginning of the Plan. If the treated acres reported by Baker and others (in press) were all thinnings in late-successional reserves, the amount of plantations thinned thus far would be about 13 percent of the total in 9 years, or a mean annual rate of 1.4 percent. At this rate of thinning, 71 years would be needed to thin all of the plantations at least once and many would become too old for thinning (80 years) under the ROD before they were treated. Better data are clearly needed to evaluate the scope of the problem, but these limited data show that the rate of thinning may not be coming close to meeting the need and intent of the Plan. The implication is that many stands are exposed to blowdown and other disturbances, and will experience delayed structural development that may jeopardize their expected contributions to the biodiversity goals of the Plan. For example, if left untreated, the plantations would probably develop fewer very large trees (e.g. >60 inches dbh) in 100 to 200 years than occur in many of today's old-growth stands.

Why do Some Species Occur More Commonly in Older Forests?

The distinctive plant, animal, and fungal communities of old-growth forests are typically associated with the habitat elements such as large trees, dead and down trees, and microclimates. Species associated with habitat structure include the northern spotted owl and the marbled murrelet. Another reason for the occurrence of species in old growth is simply the passage of time (Halpern and Spies 1995). Unique species may occur in old growth because enough time has elapsed since major disturbance that species with relatively weak dispersal powers can colonize and grow. Old-growth-associated species that disperse in this way include some vascular plants (Halpern and Spies 1995), and some lichens and bryophytes (Muir and others 2002). The implication for the Plan is that the occurrence of some rare species may not be accelerated through manipulations of forest structure. These species may simply require long periods to recolonize forests after stand-replacement disturbance. Such species would potentially be retained in natural and managed disturbances that leave structures (e.g. large live and dead trees) and patches of forest (e.g. patch retention, riparian zones) that become refugia from which the species could recolonize younger forests. The presence of some old-growth-associated species in predominantly young forest is associated with survival of large old trees (Sillett and Goslin 1999).

The Effect of Natural Disturbances on the Abundance and Spatial Pattern of the Late-Successional Reserve Network

At current rates of disturbance, the regional late-successional reserve network still appears robust and losses would be replaced by growth of smaller diameter stands into larger diameter classes. In some dry provinces, however, the rates of disturbance have been higher and the risk of substaintial loss of old forest is high. Although this risk was recognized by FEMAT and the ROD, implementing fuel reduction activities has apparently not been sufficient to reduce risk of stand-replacement disturbances. The risk assessment of FEMAT for these dry provinces is consistent with the fire condition class analysis (Schmidt and others 2002), which rated most of these areas as condition class 3, forests that have been significantly altered by fire exclusion and whose ecosystem components are at high risk of loss to fire. Under changing climate, increased threats to old forests from high-severity disturbances in dry provinces and other disturbances could lead to declines in the abundance older forests resulting in increased gaps in the reserve network among and within provinces.

Fire-Prone Forests

The Plan distinguished two major fire-regime zones: the low frequency, high-severity regimes of the northern and westside provinces and fire-prone forests of the eastern and southern provinces (e.g. eastern Cascades, Klamath, and southern Cascades) characterized by historical regimes with high frequency (fires every 10 to 50 years) and low to mixed-severity (fig. 6.8). A third type was not included: the moderate or mixed-severity fire regime (Agee 1993, Brown and others 2004). This type typically found in the western Cascade provinces where the fire regimes are a complex mixture of stand-replacing and low-severity fires. It is also found in the fire-prone provinces where topography creates a complex mosaic of fire regimes (Agee 2003). The assumption that the approaches to conserving older forests (i.e. standards and guides) should be different for the fire-prone and fire-infrequent regions of the plan still holds. Although fuel reduction treatments such as cutting out small diameter understory trees and prescribed fire are less necessary in the mixed-fire-regime areas because these forest were naturally more dense under the historical regime (Brown and others 2004), the effects of fire suppression in these types on old-growth ecosystem development could alter their structure and function in the future (Weisberg 2004). Recent fire-history research supports a strategy in which management activities, such as thinning and prescribed burning, take into account variation within those major zones that result from climate, topography, and vegetation types (Camp and others 1997, Wright and Agee 2004).

The Plan recognized the increased risks to old growth in fire-prone forest types and identified that fuel reduction activities would need to be carried out in late-successional reserves to restore desired old-growth structures and reduce risk of stand-replacement fires in old-growth and owl habitat. The assumption that fuel reduction will reduce probability of high-severity fire is still valid (Graham and others 2004), although many of the large fires in the region are limited more by climate than by fuel.

The standards and guides clearly allowed for manipulations to reduce risk of loss to stand-replacement fires in the dry provinces. Such manipulations were probably not at a high enough rate to significantly reduce the probability of stand-replacement fire in dense old growth in these provinces and restore the open old-growth types. In 2003, the only year for which data exist, it was estimated that fuel reduction activities were applied on 131,603 acres (Baker and others, in press). These data are very weak, however, in that they do not cover all forests in the Plan area and some of the data comes from forests not entirely in the Plan area. A crude upper limit of the annual area needed for treatment by mechanical means or prescribed fire can be made by estimating the area of fire-prone forest types (all ages and allocations) in the dry provinces (about 12 million acres), and assuming that 80 percent of these landscapes

(9.6 million acres) where characterized by low severity, high frequency fires with a return interval of less than 25 years (Agee 1993, Taylor and Skinner 1998). If the low end of this frequency (25 years) was restored through active management on these 9.6 million acres, then 384,000 acres would need to be treated every year. That amount would be at least three times the area treated in 2003, if we assume those numbers are a good estimate for the Plan area. The acres treated might actually have to be much higher initially because some stands might need to be treated mechanically before using prescribed fire. In practice, the area treated would be governed by landscape patterns of topography, fuel and other objectives. Consequently, not all acres and allocations potentially eligible for treatment would need to be treated. Nevertheless, the total area treated is still probably much less than is needed. The relatively low rate of fuel treatments may have several causes including lack of funding, legal challenges, and risk aversion on the part of stakeholders, regulators and managers. For example, the Fish and Wildlife Service concluded in one opinion that thinning around an owl nest would constitute "take" of an endangered species (Irwin and Thomas 2002). Everett and others (2000) estimated that a similar proportion of area would need to be burned every year in the eastern Washington Cascades to maintain landscape heterogeneity and reduce hazard from high-severity fire.

The standards and guides for these provinces appear to limit thinning in old forests in reserves. For example, although FEMAT and the standards and guides in the Plan recognized the need for mechanical treatments and prescribed fire to reduce risk of stand-replacement in these forests they do not clearly state that large areas would need to be treated and that the dual goals of owl habitat and old-growth ecosystem diversity and function can not be met without a landscape (mid-scale) strategy. These goals are often in conflict in the fire-prone provinces (Irwin and Thomas 2002) where owl habitat has increased in some forest types (e.g. ponderosa pine) as stands have become dense as a shade tolerant tree species (e.g. Abies spp.) have filled the understories as fires have been excluded. The standards and guides first emphasized treating young stands in the late-successional reserves but they are more cautious when it comes to treating older forests in reserves. For example, they stated that activities should "be focused on young stands", but that actions in older stands may be appropriate as long as "they do not prevent the LSRs from playing an effective role in the objectives for which they were established" and "should not generally result in degradation of currently suitable owl habitat." This language is somewhat ambiguous and conflicting, especially at the stand scale, where simultaneously reducing risk of loss to large pines and Douglas-firs by thinning out mid-and lower-story trees is impossible without reducing the quality of owl habitat.

Landscape level (mid-scale) strategies would identify key places for treatments, including repeated treatments. Without this approach the likelihood of sustaining suitable owl habitat will remain low. It is important also recognize that these treatments will not prevent losses of owl habitat to wildfire. Consequently, plans assume losses will occur and plan over the landscape as a whole, for replacement habitat.

Salvage in Late-Successional Reserves after Stand-Replacement Disturbance

The Plan assumed that some old forests in late-successional reserves would burn in high-severity fire during the lifetime of the plan and that the area and number of reserves was sufficient to maintain old-growth functions in spite of this loss. The goal of the reserves has clearly emphasized conservation and restoration of late-successional forests including old-growth forests. When those forests are burned by high-severity fire they 100 to 200 years or more may elapse before they return to older forest conditions. The ecological influences of old growth do not end with the death of the tree layer in a high-severity fire, however. Biological legacies of old growth, including dead trees, surviving live trees and other organisms and organic matter carry over into the young forests and can persist for many decades as the new younger forest develops (Harmon and others 1986). For example, significant amounts of dead wood from the previous stand can be found 100 years later in post-fire stands, and trace amounts can be detected in some 200-year-old stands (Spies and others 1988). The amount and duration of this legacy wood would vary greatly with species, climate, and disturbance history. The “connected old-growth network” is more than a spatial concept—it is also a temporal one, in which developmental stages are connected to each other through surviving and slow-decaying structural and compositional components of previous stages.

The Plan was somewhat vague however, when it came to the role and management of these post-fire stages in reserves. The standards and guides about salvage in late-successional reserves acknowledge that guides are intended to prevent “negative effects on late-successional habitat while permitting some commercial wood volume removal". They go on to state that some salvage may actually facilitate habitat recovery (e.g. making it easier to regenerate the site) or reduce the risk of future stand-replacing disturbances.

The ROD could be interpreted in at least two ways:

- Salvage is permitted only for ecological goals that maintain or enhance late-successional habitat with commercial wood volume as a by-product; or
- A removal of "conservative" quantities of salvage material is permitted for commercial objectives.

Several arguments can be made in support of the first interpretation. First, although a high-severity fire would kill an old-growth forest, it does not remove all of the late-successional habitat elements that will be in the young forest for many decades. Thus, removing any large dead trees would diminish amounts of late-successional habitat elements in young forests. Second, these early successional stages, with many large dead trees, contribute to an important but not often stated goal[xv] of the Plan, which is to maintain biological diversity. The stage of natural stand development after stand-replacement disturbance in old forest is particularly rare. It was not common in landscapes under a historical disturbance regime (Nonaka and Spies, in press), but occasionally it was widespread after large fires. This stage has become very rare in an era of fire suppression, salvage logging and plantation forestry. Third, salvage of dead old-growth trees would not be consistent with the precautionary principle (Kriebel and others 2001) that underlies much of the Plan's design and implementation.

At the time of the Plan, the ecological values of dead wood were known (Harmon and others 1986, Thomas 1979). Although little new research has been conducted on the ecological effects of salvage logging after stand-replacement disturbance since the Plan was adopted, the ecological value of large dead trees in early successional forests has been reaffirmed in several synthesis papers on the subject (Beschta and others 2004, Lindenmayer and others 2004, McIver and Starr 2000). In addition, no empirical evidence has emerged that salvage logging can improve the desired ecological diversity of young forest or the development of late-successional forests later in succession. Brown and others (2003) found some indication that removing large dead trees could reduce the spread and severity of reburns that often follow high-severity fires. The magnitude of this effect is unknown, and the indirect effects of salvage logging-- including soil disturbance and increased fine fuel from slash left on the site--may outweigh any benefits of removing of large fuels.

Several arguments can also be made for the second interpretation of the standards and guides for salvaging in reserves. First, option 9 in FEMAT allowed salvage for disturbances larger than 24.7 acres. Second, the language in the standards and guides implies that, where salvaging is done occur it should "retain snags that persist until late-successional conditions have developed" (C-14). In fact, very few of the fire-killed trees will persist until the next late-successional forest develops in 100 to 200 years. Most trees will decay and disappear well before the next older forest (Spies and others 1988); however, some small fraction of biomass could persist. Thus, most of the smaller diameter trees would not persist long periods of time and would not meet persistence criterion. Third, the allowance of some commercial wood production in this case would meet one of the President's principles, which was to provide for economic and social values after meeting the criteria of the environmental laws. Removing trees for commercial purposes could also be justified in support the management infrastructure needed to carry-out the broader goals of ecological restoration, which are typically under funded.

The primary benefit of the large snags is in the first few decades, first as standing dead trees and, in subsequent decades as fallen trees. Smaller diameter trees (e.g. <20 inches d.b.h.) and species with high decay rates (e.g. hemlock and true firs) could be salvaged with much less effect on biological diversity. The particular effects of different rates of salvaging operations on ecological functions in reserves are generally unknown. Consequently, scientifically identifying amount of salvaging that "should not diminish habitat suitability now or in the future" is probably impossible (C-13) for the foreseeable future.

In conclusion, the ROD did leave open the possibility of salvage logging for commercial purposes in the reserves after large stand-replacing disturbances, but it also clearly states the ecological value of dead and live trees in these situations. The ROD did not indicate any specific amounts of salvage logging that would be compatible with the major goals of the Plan. Essentially, no new scientific studies have emerged on either side of the debate that can shed light on the essential question: How much salvaging could be done before habitat suitability is diminished now or in the future? New studies outside of the Pacific Northwest indicate that widespread salvage logging can negatively affect many taxa and ecosystem processes (Lindenmayer and others 2004), but widespread salvaging was not the intent of the salvage guides in the ROD. An interpretation of the ROD that no salvage logging for commercial purposes should occur in late successional reserves would largely be based on the general ecological values associated with dead trees in post-fire vegetation, and application of the precautionary principle. An interpretation that allowed limited salvaging in reserves would be based on the judgment that the economic benefits of commercial production would be greater than the negative effects on ecological values associated with reserves.

Reforestation in Late-Successional Reserves Following Wildfire

Natural regeneration typically occurs after fire in most of the forests of the region. Consequently, reforestation activities in late-successional reserves following fire are often not needed. However, the densities of regeneration can vary widely across the region and in some situations reforestation may be warranted. For example, where seed sources of dominant conifers, such as ponderosa pine and Douglas-fir, have been lost through historical cutting of individual large trees and recent high-severity fire, some planting may be needed. Studies in southwestern Oregon showed that natural conifer regeneration can be difficult to obtain on many sites because of moisture limitations and competition with sprouting shrubs and trees (Minore and Laacke 1992). If timber production was a goal, planting and treatments of competing vegetation are clearly needed to establish conifer plantations. The amount of planting needed to restore structurally diverse forests in dry landscapes is not known, however. Historical studies of old forests have shown that natural regeneration and development of young stands took many decades, and the densities of trees in these young stands were often relatively low. In some dry landscapes, open brush fields probably persisted for long periods as trees slowly invaded. These shrubby areas were important to the general biological diversity of the landscape and can contribute nutrients such as nitrogen by nitrogen fixing shrubs. If recent fires have had a much higher proportion of high severity damage than in the past then it is possible that vegetation development after these fires would be quite different than under natural disturbances, where patches of surviving old trees and seed sources would have been common in post-fire landscapes. Under these circumstances some reforestation could be justified for ecological goals.

The Plan is Based on the Geographic Distribution of a Single Species

The Plan assumed that a region defined by the range of a single-species, the northern spotted owl, could form the basis of a cohesive unit for ecosystem management. The region encompassed a wide range of ecosystem types and disturbance regimes. The Plan attempted to deal with variability in that area through province and watershed analyses, geographic variation in standards and guides, and adaptive management areas distributed across the across the Plan area. In the first decade of implementation, however, the diversity of approaches appears to be much less was intended. Consequently, the use of a single species to define the boundaries of a complex ecosystem plan is difficult to defend ecologically or administratively.

Treatment of the Matrix for Both Ecological Values and Commodity Production

The ecological value of leaving large live trees as individuals and groups as a way of supporting older forest species in areas managed for timber production has been supported by habitat studies of individual species (Sillett and McCune 1998). In addition, fire history studies that show that many old-growth stands may have gone through periods in which the stand was partly or almost completely killed by disturbance. Approximating some of the characteristics of these natural disturbances with green-tree retention harvesting approaches in the matrix is consistent with this information. Despite the technical and scientific basis of commodity production from the matrix, harvest of older forest did not occur. No new scientific evidence has emerged that the standards and guides for the matrix, which allowed cutting of old trees, would not meet the ecological and viability goals of the Plan.

The Reserve Strategy of the Plan

The Plan has sometimes been criticized for using a reserve-based approach. At other times, it has been criticized for not placing all of the remaining old growth into “true protection”, such in a park or wilderness area. These criticisms imply that “reserve” means one thing—a no-touch-no-management zone and that a reserve approach is either not valid for dynamic forests or is the only way to conserve the old growth. The reality is that conservation biology and the Plan rest on various kinds of reserves and protected areas. Most of the protected areas allow active management for ecological goals and the matrix allows active management for a blend of commodity and ecological goals. As implemented, however, the differences among the land allocations have been much less than intended.

A reserve is defined as an, "Area of land especially dedicated to the protection and maintenance of biological diversity, and natural and associated cultural resources, and managed through legal or other effective means (IUCN 1994). It has also been defined as, "Extensive tracts managed primarily to perpetuate natural ecosystems and related processes, including biota" by Lindenmayer and Franklin (2002: 75). According to these authors, reserves are to provide:

- Examples of [natural] ecosystems, landscapes, stands, biota, etc. and contribute to natural evolutionary processes
- Strongholds for sensitive species (e.g. particular habitats or species sensitive to human intrusions)
- Control areas against which to measure effects of human activities

Reserves are an administrative or legal vehicle to reach an ecological goal rather than the goal itself. In other words, species and ecosystems do not respond to why people's activities vary across a landscape—only that they **do** vary. The ecological goals for reserves are typically so generally defined "for example, natural processes and ecosystems” that specific measures of success do not exist other than the goal of keeping direct human effects out of the area. If “natural”—little or no human presence--is the goal, then all ecological states, species, and ecosystems that develop are equally desirable. Ecological conditions in a reserve may conflict with more specific vegetation or habitat goals for species or landscapes, however. Northern spotted owl habitat in fire-prone landscapes is a good example of this conflict.

The Plan contains many types of reserves or protected areas. All of these reserve strategies are consistent with internationally recognized approaches to conservation (table 6-3). A similar although simpler set of protection classes has been developed by the Gap Analysis Program of the USGS (http://www.gap.uidaho.edu/).

Note that several of these protected areas allow active management to achieve ecological goals. For example, the late-successional reserves are closest to IUCN (1994) category IV, which allows active management for habitat and conservation objectives. Note also that the last category of protection, code VI, actually allows for producing wood products. In fact, the entire federal forest landscape has many of the attributes of IUCN- protected category VI because under the Plan, biodiversity goals are paramount, sustainable use of forests is also a goal, and no large commercial plantations are allowed (matrix standards and guides with green-tree retention do not create standard commercial plantations).

The notion of reserves implies the existence of a surrounding landscape that is not reserved or is a “matrix” of other uses, typically commodity production. Normally, the matrix is the dominant land area and the reserves are embedded in it. In the Plan, however, the matrix in most provinces is not most of the federal landscape. The Plan has created a situation in which the “matrix” in the sense of the dominant landscape is really the reserves and the commodity production areas are minority land allocations that are embedded in those areas. In another sense, the true matrix for the federal lands is the nonfederal lands, where commodity production is typically the major goal. The implication of this structure is that, because this reserve network covers very large areas, many of them in fire-prone forest types, losses of old forest will undoubtedly happen regularly within the network. Because the reserve system is so extensive, it was hypothesized that it would be robust to these losses. In most forest regions of the world, reserves are a relatively small part of the forest. Consequently, losses to habitat within these small areas can be devastating, which is less of a problem here, although, in some provinces the sizes of the disturbances can be large. The assumption that the reserve network was sufficient to meet the Plan’s goals has never been examined at province or larger scales as part of its adoption. At the landscape level, only the Blue River Landscape Study (Cissel et. al. 1999) addressed this issue.

The federal matrix was intended to allow stand-replacement logging for commodity production, but the logging has not been done to the degree expected. Consequently, the matrix and the reserves have been treated similarly in terms of regeneration harvesting and the rate of planned, stand-replacement disturbances. Consequently, the production of diverse early-successional forests, which would have been a by-product of green-tree retention logging practices in the matrix has not happened. In dry provinces this early-successional habitat has developed from wildfires; in wetter provinces, however, this habitat has probably declined, generally reducing seral-stage diversity on federal lands.

Forests are dynamic but reserve boundaries are not. This reality begs the question of whether a reserve-based strategy is the best approach. The Plan's reserves are not no-touch zones, especially in the fire-prone provinces, and the large size of the reserve network means that it is relatively robust against high severity disturbances. Still, examining alternatives would be helpful, to see if more effective strategies exist to meet the Plan's ecological goals.

One approach might be to move reserve boundaries after a stand-replacement wildfire. Some adjustments to reserves can be consistent with the Plan (FEMAT 1993: VIII-30; ROD USDA and USDI 1994b: E-18) and adaptive management. However, moving late successional reserve boundaries as a standard response to high-severity fire in LSOG was not part of the Plan and may require a reexamination of network and other components (e.g. key watersheds, aquatic). The interconnectedness of the Plan's conservation strategies[xvi] makes difficult modifying any single part of it without potentially compromising its goals.

Alternatives to the Plan's reserve strategy exist and their suitability depends on the particular desired balance between ecological and commodity goals, the decision process used to manage the forests, and the natural dynamics of the forest landscapes. The following are several possibilities:

- "Structure-based management". This approach would have no fixed reserves and the entire landscape would be managed for both ecological and commodity goals to be achieved through variable timber rotations ranging from standard industrial rotations to rotations of 150 years or more (ODF 2001). Green-tree retention may be practiced with regeneration harvests. This approach was briefly considered during FEMAT, but it was rejected for several reasons, including: to meet commodity objectives would require the logging of large areas of existing old growth; it was unknown how well sensitive species, processes, and habitats could be maintained entirely through managed systems; risks to viability of late-successional species were considered too large, it would not produce the full diversity of old-growth forest conditions (e.g. forests older than 400 years) and functions that currently exist in the region; and the road systems required to maintain active management across the landscape could be detrimental to the other goals.

- Temporary Reserves. Under this approach, a reserve would exist until the trees are killed in a stand-replacement disturbance. At this point, the reserve would revert to the matrix allocation or an adaptive management area. Unless new reserves were designated, the approach would be problematic for Plan goals because, over time, the forest would change from reserves to more active management for an even mix of biodiversity and commodity goals.

- Hybrid of disturbance-based management and reserves. The Blue River Landscape Study is an example of this approach (Cissel and others 1999), which demonstrates how watershed analysis in the Plan could have been used to revise the spatial pattern of allocations and management prescriptions based on knowledge of fire history and landscape dynamics. Reserves are designated, but the boundaries and their landscape distribution are fundamentally different from the Plan's. Riparian reserves are blocked-up into larger patches, leaving matrix areas larger and more operationally feasible. The matrix is managed on longer rotations (with greater live and dead tree retention) producing less of a gap in mid-aged stands (80-200 years) in the long run than under the Plan in which the matrix would largely be less than 80 years and the reserves would largely be over 200 years old. This plan assumes continued cutting of some older forest but at a lower rate than would happen in the Plan. Although this approach has less area in reserves that in the Plan, it produces less timber than would be expected under the fully implemented Plan because of long rotations and higher retention of live trees.

- Reserve all remaining old growth or mature and old growth. Under this approach all old-growth forests—including those in the matrix—would be reserved from logging. The timber production goals would have to come from younger natural forests and existing plantations. The effects of this alternative would depend on the definition of old forest, the expected rate of timber production, and the kind of activities permitted in the reserves. This approach would have some elements of option 1 from FEMAT, in which most of the remaining old forest was reserved and the largest numbers of species were considered to have sufficient habitat. The long-term effects of this approach are uncertain. If plantations were the main location of regeneration harvest, such an approach might perpetuate undesirable spatial patterns that were set earlier under different forest management objectives. If pattern goals were part of this strategy some plantations would have to be excluded from the timber production base, which would reduce expected timber outputs. This approach would require a different strategy in the fire-prone provinces where open, fire-dependent old-growth types have largely been replaced by late-successional types with dense understories of shade tolerant conifers. In many areas, selective logging of large pines and Douglas-firs has removed the large tree components. Thus, reserving the old-growth in these landscapes means locating the large remaining trees and using them as foci for restoration activities that would include thinning, mechanical fuel reduction and prescribed fire. Timber production in these types would have to come from smaller diameter trees that were removed in the process of protecting old, large trees. Of course, to meet owl habitat objectives, areas of dense late-successional old-growth forest would have to be retained.

- Landscape restoration in fire-prone provinces. The most urgent need for improving the effectiveness of the Plan lies in the fire-prone provinces. The standards and guides for reserves and matrix do not adequately address the landscape perspectives that are really needed to conduct ecosystem management in these areas. This approach is not simply a matter of abolishing all land allocations and using a “shifting mosaic” approach to management. The owl’s habitat requirements necessitate zoning the landscape both to provide the appropriate amount and spacing of owl habitat and to prioritize fuel treatments based on plant association groups and the landscape ecology of fire. We do not know how close the current pattern of plan allocations comes to landscape zoning pattern where the goal was to reduce risk to loss of owl habitat from fire and pathogens. It seems likely that more effective landscape strategy could be developed, especially given the losses of owl habitat that have already occurred in many provinces and the fact that matrix lands currently appear to be managed as though they were late successional reserves (i.e. little cutting of older forest for timber goals). Of course, any landscape plan would be subject to the unpredictable elements of natural disturbances, which can only be treated in a probabilistic sense. High-severity fires would still occur under more effective fuel reduction strategies, but management actions could reduce their effects.

Developing a new strategy for implementing the Plan in the fire prone provinces is beyond the scope of this document, but whatever strategy is developed could include:

- More explicit guidelines on balancing the area of dense older forests for northern spotted owl habitat and for other species, with the risks of loss to those habitats from the stand-replacement disturbances that are more likely in dense forests. For example, how large should the habitat areas be, and how should they be placed to reduce risk of loss to habitat areas? How should the habitats be placed relative to the potential vegetation (plant association groups) and disturbance regimes?
- A strategy to retain large-diameter trees for ecological and social reasons; for example, what diameters and species should be retained in restoration activities in matrix and late-successional reserves?
- A more explicit approach for restoring open old-growth forest types and landscape patterns and reducing the probability of high-severity fire. This approach would be more explicit and emphatic about the need for active management, including mechanical treatments, prescribed fire, and reestablishing seed sources of desired tree species over large areas and across all allocations. For example, what stand level prescriptions should be used, and how should they be distributed across landscapes?
- A more explicit plan for providing a sustainable flow of commodities and revenues that could be used to finance restoration programs and support local communities in these provinces.

The Role of Nonfederal Lands

The Plan addressed management only on federal lands. Although relation to nonfederal lands were considered, FEMAT did not analyze conditions or plans for nonfederal lands, other than for timber production. The Plan essentially did not assume any contribution of nonfederal lands to the late-successional goals. The FEMAT did call for working with nonfederal landowners to coordinate management across watersheds and provinces as part of an "integrated approach to ecosystem management for nonfederal lands" (FEMAT 1993: VIII-39). No evidence suggests that this occurred to any large degree, however.

The Plan made several fundamental assumptions about nonfederal forestlands:

1. The nonfederal lands would contribute little to the late-successional goals.

The inventory data suggests that this is not entirely true. The status and trends reports (table 6-1) show that significant areas of stands with medium sized trees (>20 inches d.b.h.) exist off the federal lands. This is particularly true the coastal provinces of Oregon and California, where federal lands occupy a minority of the area and where highly productive private forests occur that can grow stands with average stem diameters of 20 inches in 60 to 70 years (McArdle and others 1961). The area of large diameter (>29.5 inches) multistoried forest occurs predominantly on federal lands, although at least 20 percent occurs off federal lands, probably largely on other public ownerships. On these other ownerships these older forests are more likely to be in smaller patches or have had history of logging that reduced other structural elements, such as dead wood. Within the non-federal lands, the medium and large multi-storied forests cover about 17 percent and 3 percent respectively of the forest capable acres

(Moeur 2004). So the matrix for the federal lands is still dominated by younger forests.

Some research has also shown that this statement is not necessarily true (Holthausen and others 1995, Spies and Johnson 2003). In fact, some nonfederal forest management practices have incorporated elements of late-successional conservation objectives. For example, state forests in Coastal Oregon have adopted plans that would increase the amount of mature forest in that landscape (ODF 2001) over what it would have been if those lands were managed under an industrial forestry model. Simulation projections showed that indicators of old-growth forest structure and spotted owl habitat will increase strongly on those state forests in the northern Coast Range, although they will not reach the amounts on federal lands in that province (Spies and others, submitted). Private forest lands will not contribution much to older forest habitat values, but the area of stands with large diameter trees may show small increases ay occur as a result of stream-side protection rules in Oregon and Washington and some habitat conservation plans for northern spotted owls are on those lands.

2. The federal land alone could meet the biodiversity needs of the focal species and ecosystems without contributions from the nonfederal lands

This statement also is not necessarily true. Research in Coastal Oregon shows that the highest potential coho habitat is not on federal lands, where stream gradients are relatively steep, but on private lands and especially on non-industrial private lands, where stream gradients are gentler and more conducive to coho habitat (Burnett 2004). Furthermore in coastal Oregon, about one-third of moderate- to high-quality marbled murrelet habitat is on nonfederal lands in the Coast Range of Oregon and almost 60 percent of moderate to high quality red tree vole habitat is on nonfederal lands. Some ecosystem types that are regionally threatened, such as oak woodlands, are primarily on nonfederal lands as are many large river floodplains and wetlands.

3. The federal lands alone could meet their goals in spite of contradictory influences from nonfederal lands.

The assumption that activities on adjacent non-federal lands would not negatively influence desired conditions on federal lands is questionable but it remains untested in provinces, landscapes and watersheds dominated by nonfederal lands. This assumption is especially questionable on BLM lands. For example, in the Oregon Coast Range, 70 percent of the BLM lands fall within 3,280.8 feet of nonfederal lands (Spies and others 2002). Here, forests on federal lands may be at greater risk of invasion from non-native species, diseases, and fires that may originate on other ownerships with higher densities of roads, seed sources for non-native species, sources of fire ignition from human activities, and fuel configurations that facilitate the spread of fire. The magnitude of these influences has received relatively little study, but it could be high in some areas.

The Plan also made implicit assumptions that emphasis on protecting and restoring of late-successional habitats and species would not jeopardize the viability or diversity of other species or ecosystems not directly associated with older forest or, in other words, that a plan that focused on older forest would also provide for other elements of biological diversity. Although not stated, nonfederal lands may have been assumed to provide for other non-late-successional-species that were not provided for on the federal lands.

This assumption is not necessarily valid. Again, research in the Oregon Coast Range indicates several trends. First, successional diversity will decline on federal lands as succession moves stands and landscapes toward dominance of late-successional habitats. This trend will be mitigated by any regeneration harvesting in matrix areas and by natural stand-replacement disturbances from fire, wind, and pathogens. In some provinces, however, stand-replacement disturbances will be infrequent and many landscapes will become dominated by older forests. Second, some vegetation types will decline on all ownerships because no forest plans will provide for them. For example, hardwood forests in Coastal Oregon are projected to decline because federal plans exclusively emphasize late-successional forests and private forestlands emphasize the growth of conifer plantations. Although hardwoods could develop as a result of unplanned disturbances, such as landslides, debris flows and wildfire, most management plans have worked to greatly reduce the incidence of these disturbances. Third, diverse early- successional forests with old-growth legacies are also expected to decline. Disturbances that create these legacies are suppressed on all ownerships, and post-disturbance practices on nonfederal ownerships typically work to reduce early successional structural and compositional diversity. Although goal for the federal lands is to achieve high amounts of older forest. Forest history studies and imulation modeling suggests that, under the natural disturbance regimes, landscapes were not totally dominated by old forest, and forest landscapes were characterized by an intermixing of early-, mid- and late-successional forest types (Nonaka and Spies, in press).

The Plan also explicitly assumed that a comprehensive, integrated assessment of forest ecosystem management could be conducted by focusing primarily on late-successional forests within the federal lands. Given the interconnectedness of forest ecosystems and landscapes this focus means that the ecosystem assessment for the Plan was incomplete. For example, it did not assess the consequences of the development of a bifurcated forest condition across the region, in which federal lands were dominated by older forest managed primarily for biodiversity goals, and nonfederal lands dominated by younger forests managed for timber and other goals. This emerging pattern has implications to regional biodiversity, spread of fire and other disturbances, and protecting biodiversity on nonfederal lands. For example, when considered at a regional scale, the biodiversity protections on federal lands may allow for timber production on nonfederal lands with minimal habitat protection for some endangered species. On the other hand, landscape- and province-scale analysis shows that because of the mix of forest goals, some habitat types (e.g. hardwoods, diverse early successional vegetation) may strongly decline, with uncertain effects.

Climate Change Effects

Climate change was identified as one of the sources of uncertainties in meeting the outcomes described in the species and old-growth ecosystem assessments. The assessments for option 9 in FEMAT stated the likelihood of not achieving the most desired outcomes at about 20 to 30 percent. Climate change effects on Plan outcomes have not been formally analyzed. The consensus of the scientific community that climate change will occur has probably broadened since the Plan was developed (Oreskes 2004). The significance of these changes to the Plan is still uncertain.

The most recent climate-changes scenarios for the Pacific Northwest include (JISAO 1999):

- Increased moisture stress followed by a decline in the area of forest land as a result of drought, and increased disturbances from insects and fire. These would largely be at the current margins of forest and nonforest plant communities (e.g. east cascades); and

- An initial decrease in summer moisture stress as a result of higher precipitation, leading to an initial expansion of forests at the margins, followed by increased moisture stress and forest dieback as temperatures rise further.

Keeton and others (in press) point out that the second scenario probably less likely than the first because summer precipitation would have to increase substantially (20-30 percent) for it to improve the typical summer moisture deficits. In either case, climate change effects within the Plan area are most likely to be at lower elevations, in drier provinces at ecotones between forest and nonforest areas. Many of these effects would be manifest as increases in disturbance frequency and severity of fires, wind, disease, and insect outbreaks.

Considerations for the Plan

The Plan whose outcomes were expected to evolve over a century is already making a difference. After 10 years of monitoring, the status and trends in abundance, diversity and ecological functions of older forests area generally consistent with expectations. Although the total area of older forest has increased, and overall losses from wildfires are in line with what was anticipated, losses to fire are high within the fire-prone provinces. Given the relatively short time for monitoring and the lack of reliable information about future losses from high severity wildfires and climate change, significant uncertainties remain about the long-term trends in old forests.

Information from implementation monitoring suggests that rates of fuel treatments and restoration of structure and disturbance regimes in fire-dependent older forest types have been considerably less than is needed to reduce potential for losses of these forests to high-severity disturbance and successional change. Restoration activities in plantation are apparently also less than what is needed in moist provinces.

Landscape management strategies that balance reducing fuels with maintaining owl habitat have not been developed and could reduce the potential for future high-severity fires that destroy both owl habitat and the large conifer trees that serve as the building blocks of old-growth forest restoration.

Reexamination of the Plan's reserve strategy and alternatives indicates that active management in reserves, both dry and wet forests, would restore ecological diversity and reduce the potential for loss from high-severity fire.

Monitoring trends and reevaluation of Plan assumptions do not indicate a compelling reason for major changes to reserve boundaries in moist habitats at this time. In dry provinces, however, new landscape management strategies could be evaluated to determine if they would reduce risks of loss of older forest and owl habitat compared to what is currently in the Plan.

Given that the plan has not been implemented entirely as intended (e.g. the matrix is essentially being managed similarly to the late successional reserves) alternative landscape-level strategies to the plan could be considered in an adaptive management context to determine if other approaches might better meet the goals of the Plan.

Table 6-1—Area and percentage of older forest on federal and nonfederal[a] land: ML = medium and large conifers; LMS = large multistoried conifers

Province[b]	Federal		Nonfederal		Federal land	
	ML	LMS	ML	LMS	ML	LMS
	Acres				*Percent*	
CaCAS	356,778	24,656	320,507	26,035	52.7	48.6
CaCOA	167,582	75,017	1,425,813	240,719	10.5	23.8
CaKLA	1,833,569	385,706	321,383	25,400	85.1	93.8
OrCOA	522,962	295,504	727,137	268,009	41.8	52.4
OrECo	222,787	26,654	94,522	5,120	70.2	83.9
OrKLA	719,296	384,597	233,374	86,557	75.5	81.6
OrWCO	1,909,647	733,603	268,008	60,476	87.7	92.4
OrWil	4,644	0	194,992	0	2.3	0.0
WaECW	164,336	0	82,097	0	66.7	0.0
WaOLY	612,770	284,444	140,968	28,485	81.3	90.9
WaWCW	1,353,454	512,275	308,726	72,159	81.4	87.7
WaWLO	108	0	256,755	0	0.0	0.0
Plan area	7,867,932	2,722,454	4,374,287	812,958	64.3	77.0

Note: Totals may not add due to rounding.

[a] The area on nonfederal lands was estimated in a GIS using layers from the remote sensing vegetation layers of Moeur and others (in press) and a GIS layer of federal and nonfederal forest land in the Plan area.

[b] Province names: CaCAS = California Cascades; CaCOA = California coast; CaKLA = California Klamath; OrCOA = Oregon coast; OrECO = Eastern cascades of Oregon; OrKLA = Oregon Klamath; OrWCO = Oregon western Cascades; OrWIL = Oregon Willamette Valley; WaECW = Washington eastern Cascades; WaOLY = Washington Olympic Peninsula; WaWCW = Washington western Cascades; WaWLO = Washington Lowlands.

Table 6-2—Area and percentage of old forest lost to wildfire, and mean fire frequency in years between 1994 and 2003[a] for the entire Plan area and by province. Provinces are ordered from highest rate of loss to fire to lowest

Province[b]	LM[c]	FCA[d]	LM	Loss- fire	Period years	Annual percent rate	Decade percent rate	Freq. years
	Percent		---------*Acres*-------					
OrKla	34	2,104,367	715,485	47,600	7	0.95	9.5	105
WaECW	5	3,347,553	167,380	3,700	6	.37	3.7	271
CaKla	43	4,221,438	1,815,202	29,900	9	.18	1.8	546
OrWCO	44	4,379,051	1,935,208	18,700	7	.14	1.4	724
OrECO	15	1,477,506	221,626	800	7	.05	.5	>1000
CaCAS	36	999,795	359,926	500	9	.02	.2	>1000
WaWCW	38	3,516,105	1,336,120	300	6	0	0	>1000
CaCOA	47	357,822	168,176	0	9	0	0	>1000
WaOly	43	1,419,276	610,289	0	6	0	0	>1000
OrCOA	37	1,396,232	516,606	0	7	0	0	>1000
OrWil	25	18,521	4,630	0	7	0	0	>1000
WaWLO	5	2,173	108	0	6	0	0	>1000
Plan area			7,850,758	101,500	7.2	.18	1.8	560

Based on (Moeur and others, in press).

[a] Periods of time vary by province: California 1994-2003; Oregon 1995-2002, Washington 1996-2002.

[b] Province abbreviations are the same as in Table 1.

[c] LM = Forests with large and medium sized conifer (> 20 inches d.b.h.) as a percent of forest capable area (FCA).

[d] FCA = Forest-capable area.

Table 6-3—Correspondence of Plan land allocations to IUCN protected-area categories

	IUCN Characteristics			
Plan allocation	**Closest IUCN category**	**Code**	**Goal**	**Human intervention**
Research natural area	Strict nature reserve	Ia	Science	Minimal
Wilderness (29 percent of Plan area)	Wilderness area	Ib	Natural character and absence of human impacts	Minimal
National Park Including wilderness	National park	II	Ecosystem protection and recreation	Localized impacts, restoration
Administratively withdrawn (7 percent of area)	Natural monument	III	Specific natural feature	Possibly Restoration
LSR’s (44 percent of area)	Habitat, species management area	IV	Conservation through management intervention	restoration, active management for ecological goals only
No counterpart in Plan other than some Native American sites	Protected landscape	V	Desired cultural (historical) landscapes containing human interactions with nature	Traditional or historical (pre industrial) uses
Entire federal landscape Biodiversity goals only—80 percent Mixture of ecological and commodity goals-Federal matrix 20 percent	Managed resource protected area	VI	Sustainable use of natural ecosystems with biodiversity protection paramount	Limited harvesting allowed to provide a sustainable flow of natural products, no large commercial plantations

Figure Captions

Figure 6-1—One-hundred forty year old mature Douglas-fir stand in the western Oregon Cascade Range. Photograph by Tom Spies

Figure 6-2—Ninety-year old mature Douglas-fir stand in the western Washington Cacade Range Photograph by Tom Spies

Figure 6-3—Old-growth Douglas-fir, western hemlock forest in the Western Oregon Cascade Range. Photograph by Tom Spies

Figure 6-4—Old-growth Douglas-fir and western hemlock stand illustrating tall deep canopies in the western Cascade Range of Oregon. Photograph by Tom Spies

Figure 6-5—Open old-growth ponderosa pine with a history of surface fires at Pringle Falls Experimental Forest in the eastern Cascades of Oregon. Photograph by Tom Spies

Figure 6-6—Dense old-growth ponderosa pine stand without history of recent low severity fire at Pringle Falls Experimental Forest in the eastern Cascades of Oregon. Photograph by Tom Spies

Figure 6-7—Dense young plantation and old-growth stand in the western Oregon Cascades. Photograph by Tom Spies

Figure 6-8—Patchy pattern of fire mortality resulting from the 2002 Biscuit fire in southwest Oregon. Photograph by Tom Spies

[i] 1994. U.S. District Court. Seattle Audubon Society and others v. John L. Evans, Washington Contract Loggers Association and others.

[ii] This system was influenced by the work of Harris (1984) who applied island biogeography theory to develop a management scheme that would link preserves in an archipelago of habitat islands allowing for the movement of wildlife among them.

[iii] The Forest Plan recognizes three distinct types of monitoring: (1) implementation monitoring, which is used to verify that mandated or agreed upon activities actually take place; (2) effectiveness monitoring, which is used to establish that mandated or agreed upon activities actually accomplish the desired goal; and (3) Validation monitoring which evaluates alternative ways (perhaps more efficient ways) to accomplish desired goals.

[iv] This is not the first time we have attempted to synthesize the science aspects of the Plan. Haynes and Perez (2000) summarized what was learned, what were the new insights, and how these insights affected the direction of Plan related research.

[v] See Fedkiw (1998) and Kaufman (1960) for different historical perspectives on the USDA Forest Service history.

[vi] Details regarding the Forest Service planning process and the statutes that govern this process are readily available on Forest Service websites. Specific sites are referenced below, but a useful starting point is http://www.fs.fed.us/forum/nepa/.

[vii] Robbins in his two volume Oregon environmental history (1997, 2004) describes how the abundant forest resources and creative energies of white settlement lead to a large industrial forest products industry which provided the livelihood for “dozens of small rural communities” and helped define the sense of place that frequently motivates Oregonians “to struggle with each other for the future of the lands and homes they loved.”

[viii] For Douglas-fir this is usually seen as a mix of stem straightness, cylindrical boles, relatively small infrequent branches (or no branches in older trees), and high stiffness compared to other softwoods.

[ix] 1994. U.S. District Court. Seattle Audubon Society and others v. John L. Evans, Washington Contract Loggers Association and others.

[x] Data from Anthony and others, in press

[xi] Personal communication, Michael Furniss, Aquatic-Lands Program, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331.

[xii] Rates are 1.7 times higher for the Plan decade compared to the decade before, but the 95 percent confidence intervals strongly overlap (a valid, simple statistical test is not possible because of the likelihood that autocorrelation in the time-series data would increase or decrease the variance estimates).

Further, this increase disappears when the 2002 fire year, with the 500,000-acre Biscuit Fire, is not considered.

[xiii] Personal communication with senior managers group (informal interagency committee)

[xiv] The net annual increase of 2.2 percent in stands with a quadratic mean diameter (qmd) of at least 20 inches probably results largely from growth and development of natural stands with qmd's greater than 17.7 inches in the 1990s. Natural Douglas-fir stands of this diameter would probably be 80 to 100 years old, assuming site class III (McArdle and others 1961). The immediate effects of thinning on the size distribution of plantations, and thus on qmd, might account for some of this increase but most plantations on federal lands were less than 40 years old in the mid 1990s and would be expected to have qmd of less than 13.8 inches at that time. Thinning from below to remove smaller diameter classes would not change stand structure enough to increase qmd beyond 20 inches, in most cases.

[xv] See appendix B-1 in the ROD (USDA and USDI 1994b).

[xvi] Option 9, was an attempt to achieve efficiency through coordination of aquatic and terrestrial strategies and ecosystem and species strategies.